



Kings River Conservation District

Lower Kings Basin Groundwater Management Plan Update



TABLE OF CONTENTS

TABLE OF CONTENTS.....	i
List of Tables	v
List of Figures.....	v
SECTION 1 INTRODUCTION.....	1-1
1.1 Introduction.....	1-1
1.2 Lower Kings Basin and Water Management Areas.....	1-2
1.3 Purpose	1-5
1.4 Stakeholder and Agency Participation.....	1-7
Process for Adoption.....	1-9
1.5 Previous Groundwater Management Plans and Related Efforts	1-9
Water Management Area A	1-10
Water Management Area B.....	1-10
Water Management Area C	1-11
Other Related KRCD and GWMP Actions in the Lower Kings Basin	1-12
Related GWMPs and Planning Efforts	1-12
1.6 GWMP Components and Consistency with the California Water Code.....	1-12
1.7 Contents of the GWMP	1-14
SECTION 2 WATER RESOURCES SETTING AND CURRENT CONDITIONS	2-1
2.1 Scope and Approach	2-1
2.2 Physical Setting.....	2-2
Groundwater Basin	2-2
Basin Topography	2-4
Geology	2-4
Land Subsidence.....	2-7
Soils and Surface Recharge Potential.....	2-9
2.3 Land Use and Water Demand	2-9
Climate-Precipitation and Evapotranspiration	2-14
2.4 Groundwater Conditions and Supplies	2-14

	Groundwater Levels within the WMAs	2-16
	Groundwater Occurrence, Flow, and Changes in Storage	2-16
	Change in Groundwater Storage.....	2-26
	Surface Water–Groundwater Connection.....	2-29
2.5	Surface Water Supplies	2-30
	Kings River Surface Water Supplies	2-32
	Kings River Supply and Delivery Facilities in the Lower Kings Basin.....	2-32
2.6	Water Quality.....	2-39
	Surface Water Quality.....	2-39
	Groundwater Quality	2-41
SECTION 3 GOALS AND OBJECTIVES		3-1
3.1	Goals and Objectives.....	3-1
3.2	Basin Management Objectives.....	3-2
	Method and Approach	3-3
	Groundwater Stabilization BMO	3-4
	Project Development BMO.....	3-4
	Potential Benefits of Meeting the BMOs and Proposed Projects	3-9
SECTION 4 GROUNDWATER MANAGEMENT OPTIONS.....		4-1
4.1	Surface Water Options.....	4-2
	New Kings River Surface Water Storage	4-2
	Small-Scale Surface Water Storage.....	4-2
	In-Basin Surface Water and Flood Flows	4-3
	Water Transfers.....	4-6
	Out-of-Area Surface Water Rights or Storage	4-9
	Out-of-Basin Flood Flows.....	4-9
	Reoperation of Pine Flat Reservoir	4-10
4.2	Groundwater Recharge Options	4-11
	Direct Recharge to Groundwater	4-11
	In-Lieu Recharge.....	4-19
	Regional Groundwater Banking.....	4-20
4.3	Other Potential Plan Elements.....	4-23

	Land Acquisition	4-23
	Conveyance Facilities.....	4-24
	Water Conservation	4-25
	Groundwater Monitoring.....	4-26
4.4	Groundwater Quality Protection Options	4-27
	Prevent Groundwater Quality Degradation.....	4-28
	Changes in Surface Water or Groundwater Flow and Quality.....	4-28
	AB 3030 Water Quality Related Options and Program Integration.....	4-30
SECTION 5 FINANCING AND GOVERNANCE OPTIONS		5-1
5.1	BAP Issues and Planning Principles	5-1
5.2	Financing	5-3
	Funding Sources	5-4
5.3	Management and Governance.....	5-7
	Methods of Groundwater Management in California	5-7
	Kings Basin Groundwater Management.....	5-8
	Potential Approaches for the Lower Kings Basin.....	5-8
	Individual Interested-Based Model.....	5-9
	Mutual Interest-Based Model.....	5-10
SECTION 6 MANAGEMENT AND IMPLEMENTATION PLAN		6-1
6.1	GWMP Components.....	6-1
6.2	Component 1 - Development of Near Term Local Recharge Projects	6-1
	Project Actions in Area A	6-2
	Project Management Actions in Area B.....	6-4
	Management Actions in Area C	6-6
	Funding for Near-Term Projects	6-6
6.3	Component 2 - Long-Term Groundwater Recharge and Banking.....	6-7
6.4	Component 3 - Stakeholder Involvement, Plan Oversight and Management.....	6-9
	Principles For Plan Management and Implementation	6-9
	Support and Coordination	6-10
	Governance, Plan Oversight and Organizational Structure.....	6-11
	Funds and Funding	6-12

	Conflict Resolution.....	6-13
6.5	Component 4 - Monitoring and Analysis Program.....	6-13
	Groundwater Quality Monitoring.....	6-14
	Land Surface Elevation Monitoring.....	6-15
	Protocols for Collection of Groundwater Data.....	6-16
	Monitoring Surface Water-Groundwater Interaction.....	6-16
	Support Development of Kings Basin Groundwater Data Center.....	6-17
	Support Development of a Regional Integrated Hydrologic Model.....	6-18
6.6	Component 5 - Common Elements for Groundwater Resource Protection.....	6-19
	Well Construction Policies.....	6-19
	Protection of Recharge Areas.....	6-20
	Control of the Migration of Contaminated Groundwater.....	6-20
	Monitoring of Saline Water Intrusion.....	6-21
SECTION 7 REFERENCES.....		7-1
APPENDIX A LOWER KINGS BASIN GWMP RESOLUTION		A-1
APPENDIX B DRAFT GWMP ADOPTION RESOLUTION		B-1
APPENDIX C LAND AND WATER USE		C-1
C.1	Land and Water Use	C-1
	Current Land and Water Use.....	C-1
	Projected Land and Water Use	C-1
APPENDIX D GROUNDWATER EVALUATION		D-1
D.1	Groundwater Occurrence and Movement.....	D-1
D.2	Analysis of Groundwater Levels.....	D-2
	Details of Analysis.....	D-2
D.3	Analysis of Groundwater Storage.....	D-4
D.4	Summary of Findings.....	D-5
APPENDIX E SURFACE WATER EVALUATION.....		E-1

E.1	Surface Water Availability	E-1
E.2	Background	E-1
E.3	Kings River Surface Water Supply System.....	E-2
	Pine Flat Reservoir.....	E-2
	Diversion and Canal System.....	E-2
E.4	Analysis.....	E-2

LIST OF TABLES

Table 1.1.	Basin Advisory Panel Participants	1-9
Table 1.2.	Lower Kings Basin GWMP Components	1-13
Table 2.1.	Summary of WMA Demands and Land Use	2-13
Table 2.2.	Cumulative Overdraft and Average Annual Overdraft	2-29
Table 3.1.	BMO Measurable Components.....	3-4
Table 4.1.	Summary of Pipeline and Reservoir Options	4-21
Table 5.1.	Issues and Concerns	5-2
Table 6.1.	Summary of Estimated Costs for Near-Term Lower Kings Basin Groundwater Recharge Projects.....	6-7
Table C.1.	Current Land Use Summary	C-2
Table C.2.	Projected Land Use Summary	C-3
Table D.1.	Summary of Groundwater Overdraft Evaluation.....	D-5
Table E.1.	Summary of Lower King Basin Canal Characteristics	E-2

LIST OF FIGURES

Figure 1.1	Groundwater Basins and KRCD Divisions	1-3
Figure 1.2	Areas of Prior GWMPs	1-4
Figure 1.3	Areas and Water Management Areas	1-6
Figure 1.4	Boundaries of Cities and Water Agencies	1-8
Figure 2.1	Groundwater Basins	2-3
Figure 2.2	Surface Geology and Geologic Cross Section	2-5
Figure 2.3	Representative Geologic Cross Section.....	2-6
Figure 2.4	Impermeable Clay Layers.....	2-8
Figure 2.5	Hydrologic Soils Group	2-10

Figure 2.6 General Land Use.....	2-11
Figure 2.7 Summary of Land Use and Water Demand in Lower Kings Basin	2-12
Figure 2.8 Average Monthly Reference Evapotranspiration (ET) at the Fresno State CIMIS Station & Average Monthly Precipitation at Fresno Yosemite International Airport.....	2-15
Figure 2.9 Location of Representative Groundwater Wells	2-17
Figure 2.10 Groundwater Trends for WMA A	2-18
Figure 2.11 Groundwater Trends for WMA A1	2-19
Figure 2.12 Groundwater Trends for WMA B.....	2-20
Figure 2.13 Groundwater Trends for WMA B1.....	2-21
Figure 2.14 Groundwater Trends for WMA B2.....	2-22
Figure 2.15 Groundwater Trends for WMA C	2-23
Figure 2.16 Groundwater Trends for WMA C1	2-24
Figure 2.17 Spring 2000 Groundwater Levels	2-25
Figure 2.18 Spring 1950 Groundwater Levels	2-27
Figure 2.19 Groundwater Level Change Between Spring 1950 and Spring 2000.....	2-28
Figure 2.20 Groundwater Elevations in Area A Compared to Pine Flat Outflow	2-31
Figure 2.21 Diversion Weirs.....	2-33
Figure 2.22 Annual Flow Volume Below Peoples Weir	2-34
Figure 2.23 Kings River flow Below James Weir.....	2-35
Figure 2.24 Kings River Exceedance Curve Below James Weir During Flood Release Periods.....	2-36
Figure 2.25 Water Conveyance Facilities	2-38
Figure 3.1 Groundwater Trends for Area A	3-5
Figure 3.2 Groundwater Trends for Area B.....	3-6
Figure 3.3 Groundwater Trends for Area C.....	3-7
Figure 3.4 Cumulative Change in Groundwater Storage for WMA A Cumulative Mass Balance Analysis.....	3-10
Figure 3.5 Cumulative Change in Groundwater Storage for WMA B Cumulative Mass Balance Analysis	3-11
Figure 4.1 Kings River Place of Use	4-4
Figure 4.2 Existing Recharge Facilities and Conceptual Layout of Potential Recharge Projects	4-13
Figure 4.3 North Fork Group Potential Recharge Areas.....	4-15
Figure 4.4 McMullin Recharge Project Area.....	4-17

Figure 4.5 Raisin City Recharge Project with Water from FID Canals	4-18
Figure 4.6 Raisin City Recharge Project with Water from Fresno Treatment Plant.....	4-22
Figure C.1 Detailed Land Use.....	C-5
Figure C.2 Detailed Projected Land Use	C-6
Figure D.1 Depth to Groundwater Contours Spring 2003.....	D-6
Figure D.2 Groundwater Level Contours Spring 1950	D-7
Figure D.3 Groundwater Level Contours Spring 1970	D-8
Figure D.4 Groundwater Level Contours Spring 1978	D-9
Figure D.5 Groundwater Level Contours Spring 1984	D-10
Figure D.6 Groundwater Level Contours Spring 1995	D-11
Figure D.7 Groundwater Level Contours Spring 2000	D-12
Figure D.8 Change in Groundwater Levels between Spring 2000 and Spring 1950.....	D-13
Figure D.9 Location of Monitored Groundwater Wells.....	D-14
Figure D.10 Location of Representative Groundwater Wells	D-15
Figure D.11 Groundwater Hydrograph for Well 14S17E05D001M in WMA A	D-16
Figure D.12 Groundwater Hydrograph for Well 15S17E13R002M in WMA A.....	D-17
Figure D.13 Groundwater Hydrograph for Well 15S18E02A001M in WMA A	D-18
Figure D.14 Groundwater Hydrograph for Well 15S18E30L001M in WMA A.....	D-19
Figure D.15 Groundwater Hydrograph for Well 15S17E28K001M in WMA A1	D-20
Figure D.16 Groundwater Hydrograph for Well 17S18E09R001M in WMA B	D-21
Figure D.17 Groundwater Hydrograph for Well 16S17E24F001M in WMA B.....	D-22
Figure D.18 Groundwater Hydrograph for Well 17S19E10A001M in WMA B.....	D-23
Figure D.19 Groundwater Hydrograph for Well 17S20E33A001M in WMA B1.....	D-24
Figure D.20 Groundwater Hydrograph for Well 18S19E14E001M in WMA B1	D-25
Figure D.21 Groundwater Hydrograph for Well 17S20E01C001M in WMA B2.....	D-26
Figure D.22 Groundwater Hydrograph for Well 17S21E03C001M in WMA B2.....	D-27
Figure D.23 Groundwater Hydrograph for Well 18S19E35J002M in WMA C	D-28
Figure D.24 Groundwater Hydrograph for Well 19S20E22C001M in WMA C.....	D-29
Figure D.25 Groundwater Hydrograph for Well 20S20E07H001M in WMA C1	D-30
Figure D.26 Groundwater Trends for WMA A	D-31
Figure D.27 Groundwater Trends for WMA A1	D-32
Figure D.28 Groundwater Trends for WMA B.....	D-33
Figure D.29 Groundwater Trends for WMA B1.....	D-34

Figure D.30 Groundwater Trends for WMA B2.....	D-35
Figure D.31 Groundwater Trends for WMA C	D-36
Figure D.32 Groundwater Trends for WMA C1	D-37
Figure D.33 Distribution of Specific Yield in Lower Kings Basin.....	D-38
Figure E.1 Kings River Annual Streamflow.....	E-5
Figure E.2 Diversion Weirs	E-6
Figure E.3 Kings River Flow Below Peoples Weir	E-7
Figure E.4 Kings River Flow Below Lemoore Weir	E-8
Figure E.5 Kings River Flow Below Island Weir.....	E-9
Figure E.6 Kings River Flow Below Crescent Weir	E-10
Figure E.7 Kings River Flow Below Stinson Weir.....	E-11
Figure E.8 Kings River Flow Below James Weir	E-12
Figure E.9 Kings River Exceedence Below Peoples Weir.....	E-13
Figure E.10 Kings River Exceedence Below Lemoore Weir	E-14
Figure E.11 Kings River Exceedence Below Island Weir	E-15
Figure E.12 Kings River Exceedence Below Crescent Weir.....	E-16
Figure E.13 Kings River Exceedence Below Stinson Weir	E-17
Figure E.14 Kings River Exceedence Below James Weir.....	E-18
Figure E.15 Kings River Exceedence Below James Weir during Flood-Release Periods.....	E-19
Figure E.16 Liberty Canal Diversions and Entitlements.....	E-20
Figure E.17 Laguna I.D. Diversions and Entitlements	E-21
Figure E.18 Murphy Slough Diversions and Entitlements.....	E-22
Figure E.19 Crescent Canal Diversions and Entitlements	E-23
Figure E.20 Stinson Canal Diversions and Entitlements.....	E-24
Figure E.21 Available Water for Diversions Under Entitlement at Liberty Weir during Flood Release Periods	E-25
Figure E.22 Available Water for Diversions Under Entitlement at Murphy Slough Weir during Flood Release Periods	E-26
Figure E.23 Available Water for Diversions Under Entitlement at Laguna I.D. during Flood Release Periods	E-27
Figure E.24 Available Water for Diversions Under Entitlement at Crescent Weir during Flood Release Periods	E-28
Figure E.25 Available Water for Diversions Under Entitlement at Stinson Weir during Flood Release Periods	E-29

1.1 INTRODUCTION

Managing groundwater to meet current and future water needs is a significant challenge in the Lower Kings Basin. The economy and population of Fresno County continue to expand and place additional stress on the local surface water and groundwater supplies. Agricultural land uses and water needs throughout the basin are relatively stable, but increased production costs stress the farm economy. Competition for available water supplies has increased both locally and regionally, and changes in water policy dictate increased environmental use throughout the region and the state. There are finite local supplies, limitations in the ability to fund new projects, and complex legal and political challenges facing the Lower Kings Basin.

Lower Kings Basin water interests need to be united to meet these challenges. Regional cooperation is needed to wield influence at the state and federal levels; to compete for funding with large, regional organizations and well-funded coalitions; and to overcome technical and organizational challenges. The development of an integrated Lower Kings Basin Groundwater Management Plan (GWMP) is an important step in the process to define a clear strategy to develop cost-effective water supplies and to locally manage the groundwater basin.

Properly managed, the Lower Kings Basin will provide for the water needs of the area for many years, but caution is appropriate since the long-term sustainability of groundwater resources is threatened by “overdraft”. This means that, on an annual basis, more water is removed from storage than is returned, resulting in declining groundwater levels, increased pumping cost, and potential conflicts over the available supply. The depletion of stored groundwater can offer an opportunity by providing a substantial volume of storage capacity.

Local and regional benefits and water needs can be met by using the storage space for conjunctive use, banking water in wet years for removal during dry years, capturing flood flows that would otherwise leave the area, and increasing the region’s water supply by importing water from other areas. To be successful in both economic (highest benefit, lowest cost) and engineering terms (highest yield), local problems must be put in the context of regional solutions, and local interests must work together to build facilities that produce tangible water supply benefits. Conjunctive use projects could provide both local and regional benefits, and regional support could defray or distribute the costs of projects needed to stabilize and recover the groundwater basin.

1.2 LOWER KINGS BASIN AND WATER MANAGEMENT AREAS

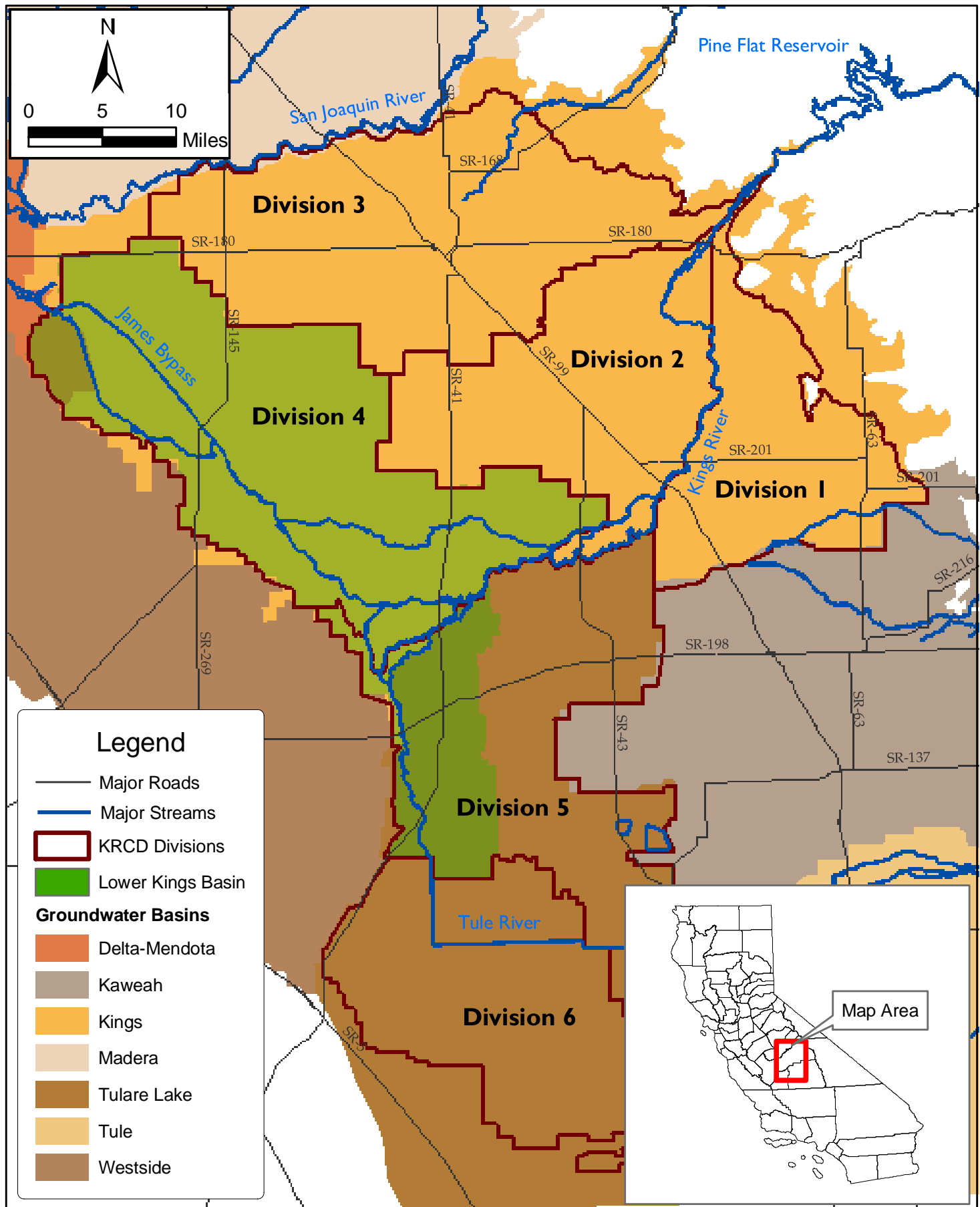
For many years, water users have been managing surface water and groundwater supplies through conjunctive use, and this Groundwater Management Plan (GWMP) is the latest in a long history of water management efforts in the Lower Kings Basin. An important part of this of water management history was the formation in 1951 of the Kings River Conservation District (KRCD) through passage of the KRCD Act.

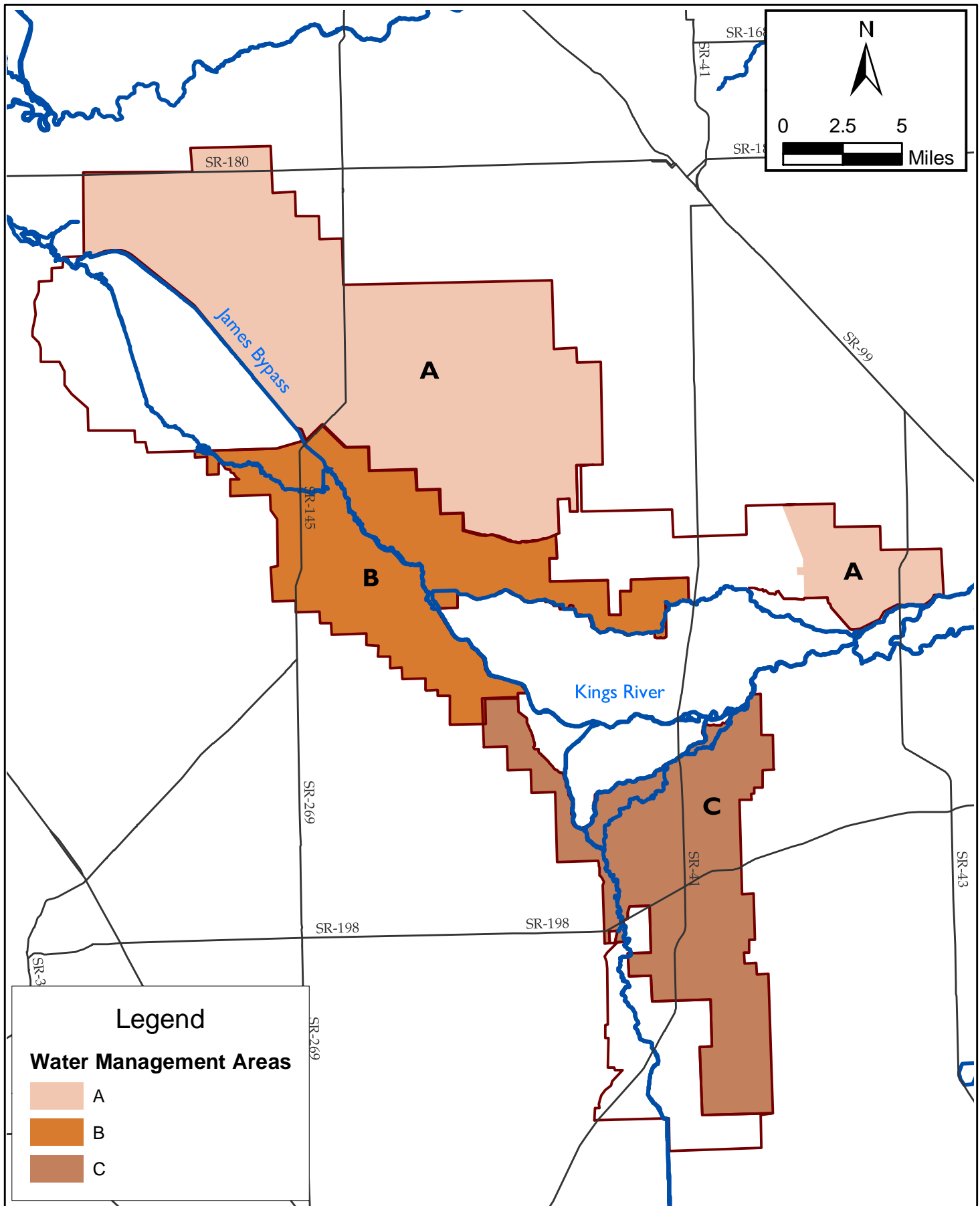
KRCD is a legislatively defined special district that supports local interests in water planning and management, develops projects, collects groundwater data, and prepares an annual report of groundwater conditions; however, KRCD does not have the legislative authority to manage groundwater. There are six “divisions” within KRCD. Figure 1.1 provides a regional map and the location of those divisions. The Lower Kings Basin is generally located within KRCD divisions 4 and 5 in Fresno and Kings Counties. The Lower Kings Basin planning area covered by this GWMP is located in the southern part the San Joaquin Valley Groundwater Basin. As shown in Figure 1.1, the planning area overlies the Kings Subbasin, as defined in the California Department of Water Resources (DWR) Bulletin 118 (DWR 2003).

The historical groundwater level hydrographs and water level contours document declining water levels and indicate overdraft of the groundwater basin. In 1989, the KRCD Board of Directors (Board) adopted a policy to promote development of additional groundwater recharge facilities in cooperation with other water districts. KRCD has worked with local water districts and ditch companies in the Lower Kings Basin to prepare groundwater management plans for separate areas within its jurisdiction.

Three separate and independent groundwater management plans were prepared by KRCD staff for Water Management Areas (WMAs) designated as A, B, and C; shown on Figure 1.2 (KRCD 1995, 1996, 1998); and adopted by the Board. A number of other water districts in the Lower Kings Basin also produced separate plans to meet the requirements of Assembly Bill (AB) 3030 and qualify for state funds. Boundaries were based on areas with similar issues, stakeholder acceptance, jurisdictional boundaries, hydrogeology, and existing water management facilities.

Since adopting the previous groundwater management plans, KRCD has worked with local stakeholders to implement the recommendations included in the management plans. One recommendation contained in all of the plans was to continue to work with Lower Kings Basin agencies and stakeholders to develop cooperative efforts to mitigate groundwater overdraft and overcome the political and financial challenges that have historically constrained implementation of projects that would increase water supply and improve supply reliability.



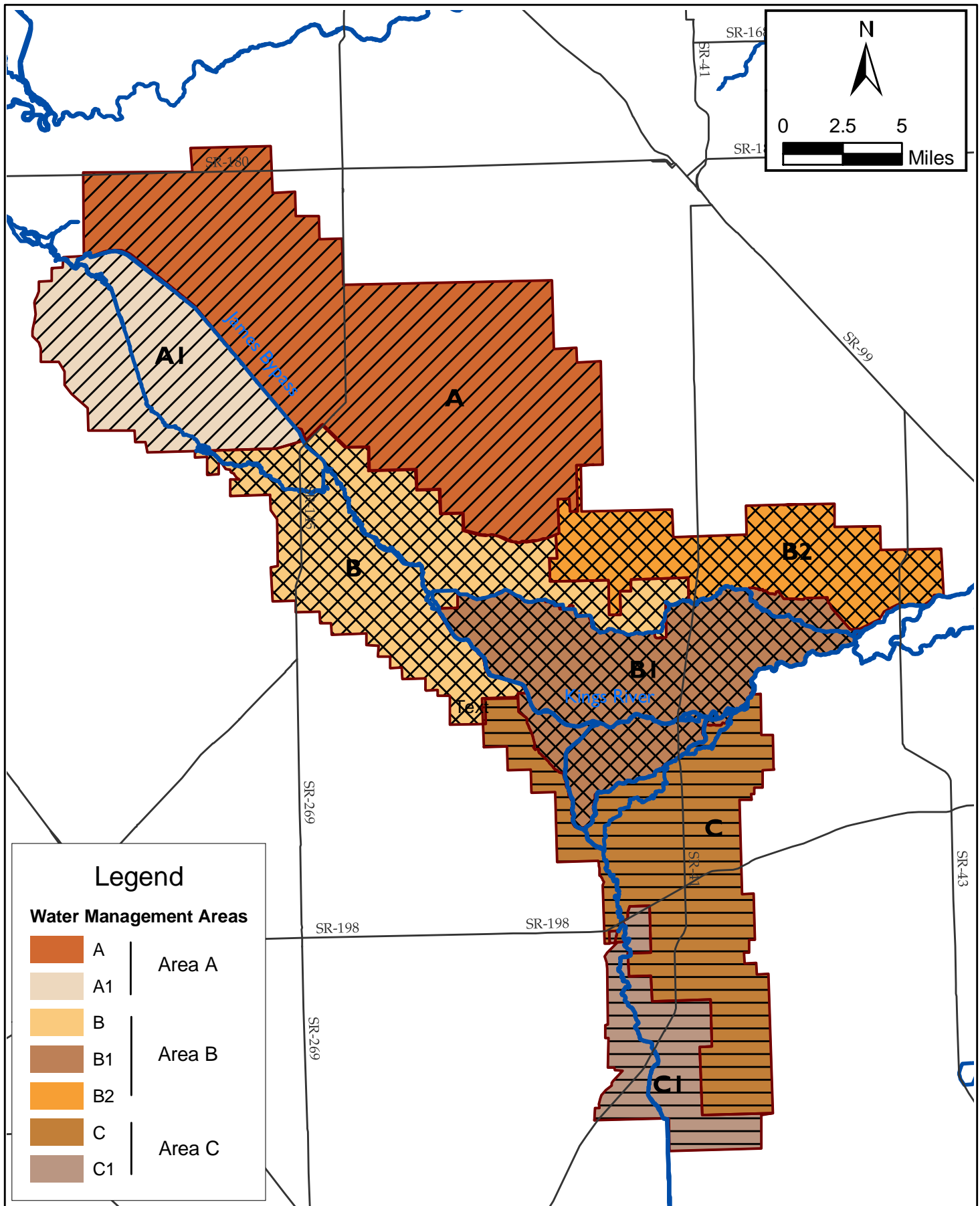


The stakeholders have recognized that the groundwater basin is one hydrogeologic unit. As part of the GWMP, WMAs A, B, and C were expanded to be more inclusive of the overlying groundwater basin. In expanding the Areas, the stakeholders sought to recognize the unique geographic distribution of the water supply problems and the water management systems in the Lower Kings Basin. Figure 1.3 presents the expanded WMAs. Throughout this text, reference to the “Area” refers to all of the WMAs with the same letter designation. Hence, Area A includes the original WMA A and WMA A1; with the exception that eastern-most portion of the original area A was reassigned to the new WMA B2; Area B includes the original WMA B, and WMA B1 and WMA B2, and Area C include the original WMA C and WMA C1. These designations were discussed and accepted by the BAP at the February 2005 meeting. The WMAs were used as accounting units to analyze water demands, evaluate groundwater levels and quality trends, and develop engineering solutions that recognize organizational and management differences in the Lower Kings Basin. Each of the Areas has specific Basin Management Objectives (BMOs), action plans, and implementation programs that are incorporated into the overall Lower Kings Basin GWMP.

1.3 PURPOSE

The purpose of this document is to update and integrate the previously prepared GWMPs to reflect changes in the state law; document progress in implementing the previous GWMPs; review, enhance, and coordinate existing groundwater management projects, programs, and policies; and define actions for developing project and management programs to address overdraft and ensure the long-term sustainability of groundwater resources in the Lower Kings Basin. This GWMP provides action items that, when implemented, is intended to maintain or enhance water levels and water quality, minimize land subsidence, and manage available surface and groundwater. As documented in this GWMP, the planning process was conducted to:

- Develop general consensus among Lower Kings Basin stakeholders regarding the characterization of the area’s water problems, current and future demands, and groundwater conditions;
- Document the groundwater management goals and objectives, including specific BMOs;
- Develop unique solutions for Areas A, B and C and common programs for the entire Lower Kings Basin;
- Develop management plan components to stabilize the basin groundwater levels, and begin to recover the basin groundwater levels, through conjunctive use and banking that would include surface water supply, conveyance, recharge, and management components; and



Lower Kings Basin GWMP Update

Areas and Water Management Areas

April 2005

Figure 1.3

- Provide an implementation plan and define the ongoing process to continue cooperation, build projects, and meet state requirements.

1.4 STAKEHOLDER AND AGENCY PARTICIPATION

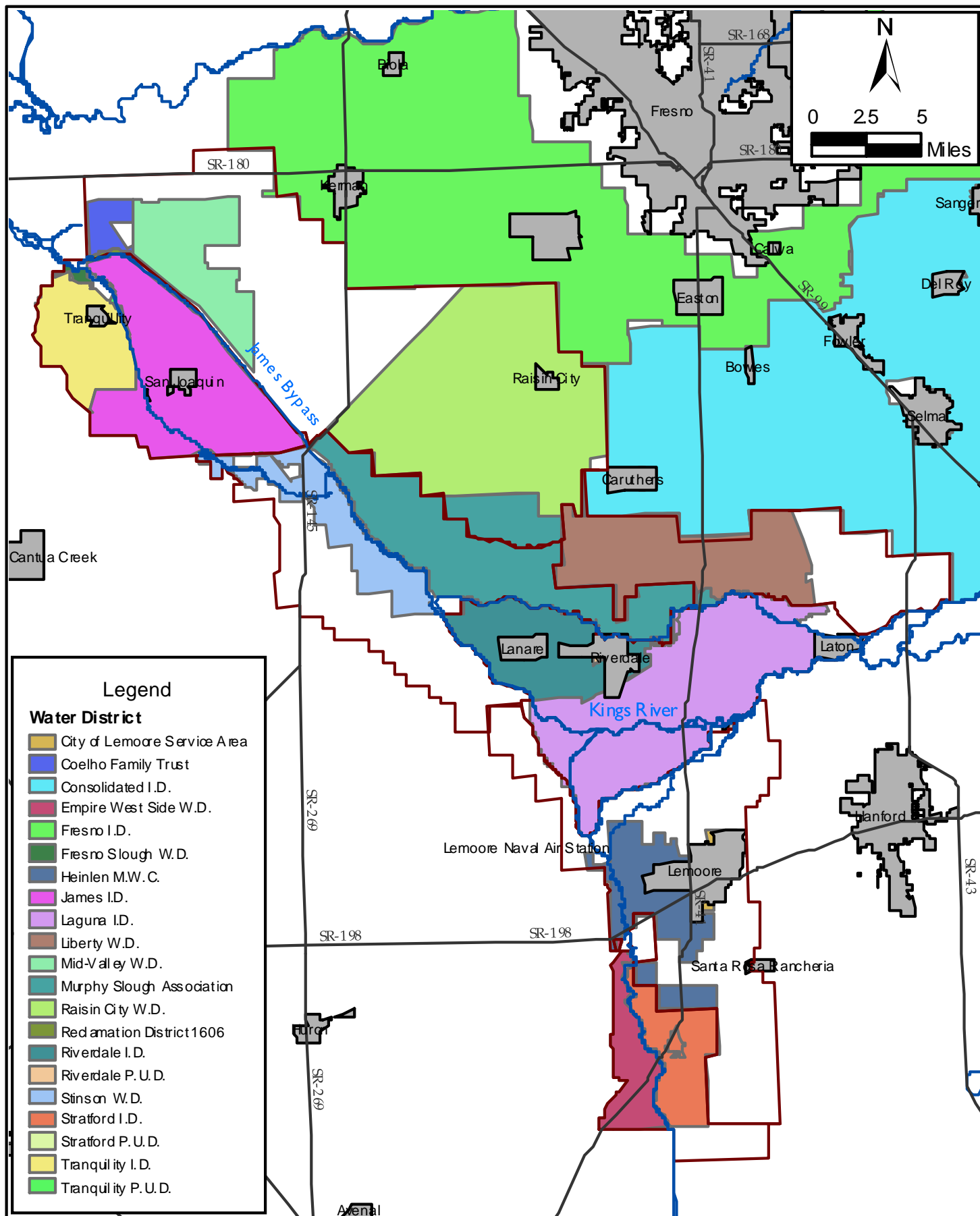
At a regularly scheduled and announced public hearing of the Board on November 12, 2002, a resolution was approved to seek grant funding for a project to update the GWMPs (Appendix A). The Board recognized the need to update the plans to comply with the revised state requirements as defined in Senate Bill 1938 (SB 1938). KRCD prepared and submitted a grant application to DWR seeking funding from the Local Groundwater Management Assistance Act of 2000 (AB 303) and funding was awarded by DWR in June 2003. A contract to prepare the GWMP was awarded by the Board in November 2004 during a regularly scheduled and announced public hearing.

The Lower Kings Basin Advisory Panel (BAP) was organized by KRCD to participate and direct the development of the GWMP. Meetings were held through fall and winter 2004 and spring 2005 to coordinate stakeholder input and incrementally develop the GWMP.

The BAP used a consensus-based approach to groundwater management. The agencies and stakeholders determined that a consensus-based approach to water resources planning and conjunctive water management would increase the likelihood of implementing projects and management actions that are equitable, affordable, and locally controlled, and provide far-reaching local and regional benefits. In addition, such cooperative efforts are intended to reduce the potential for conflicts over water and to increase public support, political influence of the region, and the probability of obtaining local and state funding.

There are a number of existing cooperative efforts within the Lower Kings Basin and groups have formed to implement previous GWMP recommendations and have provided input to this GWMP. The groups have been supported by KRCD and include the McMullin Group in Area A and the North Fork Group (NFG) in Area B. In addition to the BAP meetings, a number of meetings were held with ditch company and water district staff to obtain available data, establishes objectives, discuss project operations, and identify project concepts.

All of the overlying irrigation districts, ditch/water companies, and incorporated cities and counties (Figure 1.4) were invited to participate in the GWMP development. The BAP was open to all stakeholders. KRCD coordinated the BAP, established meeting dates and agendas, and prepared meeting notes and minutes as needed. There was active participation by 15 agencies and ditch companies, as listed in Table 1.1. The BAP was formed to support and provide leadership to develop the GWMP and identify potential recharge projects in the Lower Kings Basin.



Lower Kings Basin GWMP Update

Boundaries of Cities and Water Agencies

April 2005

Figure 1.4

Table 1.1. Basin Advisory Panel Participants

Agency or Company	Representative
Burrel Ditch Co. c/o Maddox Farms	Doug Maddox
Clark Forks Reclamation Dist. #2069	JoAnna Alves
Corcoran Irrigation Company	Thomas Vernon
Crescent Canal Company	Mark Borba
John Heinlen Mutual Water Company	Ronnie Silva
Laguna Irrigation District	Scott Sills
Last Chance Water Ditch Company	Neil Bellamy
Lemoore Canal and Irrigation Company	Ronnie Silva
Liberty Canal Company	John Coelho
Liberty Mill Race Company	Brad Harlan
Peoples Ditch Company	Dean Kuntz
Raisin City Water District	Jerry Boren
Reed Ditch Company	Mark McKean
Riverdale Irrigation District	Dean Jensen
Stratford Irrigation District	Charles Meyer

PROCESS FOR ADOPTION

The GWMP will be presented to the Board at a regularly scheduled and publicly announced meeting in May 2005. The draft plan will receive written and oral public comment before adoption by resolution of the Board. A draft resolution supporting adoption and defining how areas will obtain coverage is presented in Appendix B. Once adopted, the other local agencies will schedule and conduct meetings to consider adoption of the plan and seek coverage under the plan. None of the local agencies will be covered by the GWMP unless they specifically seek to be included in the GWMP and appropriate action is taken by the governing body.

1.5 PREVIOUS GROUNDWATER MANAGEMENT PLANS AND RELATED EFFORTS

The purpose of this section is to briefly describe the previous GWMPs and progress made in implementing their recommendations. Each of the previous GWMPs documented the current and future land use and water demand, water supplies, conveyance facilities, regional and site-specific hydrogeologic conditions affecting recharge and groundwater storage, and water budgets for their respective areas. Each individual GWMP briefly described the potential alternatives that could help overcome overdraft, including land fallowing, changing crop types, limiting groundwater extractions, and developing conjunctive use facilities. The unique features and findings of the plans are described below.

WATER MANAGEMENT AREA A

The GWMP for WMA A (KRCD 1995) concluded that regional conditions were generally favorable for artificial recharge and conjunctive use. The report documented the near total reliance on groundwater, the large cone of depression, and extensive overdraft in WMA A, noting that the majority of the local water demand was met through underflow from adjacent areas.

The GWMP also concluded that the area is a prime candidate for conjunctive use and water banking. Constraints to artificial recharge and groundwater storage were identified and related primarily to limitations or lack of facilities to divert and convey water, uncertainty regarding availability of unallocated water in Kings River, and the episodic nature of the flood flows available for recharge. The report also noted the need for a feasibility study and site-specific review of local hydrogeologic conditions where direct recharge might be possible, and further recommended developing or expanding the relationships between local agencies and the state.

KRCD and local stakeholders formed the McMullin Group to build relationships, undertake the recommended feasibility studies, and implement other aspects of the WMA A GWMP. The McMullin Group was formed in 1999 and comprises James Irrigation District (ID), Mid-Valley ID, Raisin City Water District (WD), Tranquility ID, and Terranova Ranch, Inc. Both the James ID and Tranquility ID prepared independent GWMPs for their jurisdiction.

Since its formation, the McMullin Group has met on a regular basis. As indicated in the minutes from the meetings, the group developed local funding and cost sharing sources, coordinated procurement of grant funds, and identified and worked to resolve issues related to implementation of conjunctive use and groundwater recharge projects. KRCD has provided staff support to the group. KRCD also prepared a grant proposal and obtained funding under Proposition 13 from DWR for the feasibility study, drilling, site characterization, and preliminary design of conjunctive use projects at two locations. DWR awarded funds in 2002 for the feasibility investigations. The feasibility study is scheduled to be completed in early 2005.

WATER MANAGEMENT AREA B

KRCD prepared the GWMP for WMA B (KRCD 1996), which was adopted by the Board on February 12, 1996. The WMA B GWMP concluded that the area was favorable for additional artificial recharge and conjunctive use, and documented the need for a feasibility study and site-specific review of local hydrogeologic conditions where direct recharge may be possible. Overdraft was determined to be much less than that in WMA A. Conjunctive use projects in WMA B are less constrained than those in WMA A because many areas have facilities to convey

water to potential sites, and many of the overlying water districts and ditch companies have existing water rights and entitlements. Projects in this part of the Lower Kings Basin planning area have less institutional, legal, or regulatory obstacles than those in WMA A.

To implement the WMA B GWMP, the local stakeholders formed the NFG and entered into a Memorandum of Understanding (MOU) with DWR and KRCD in September 2000. The original WMA B was then expanded to the current boundaries. The purpose of the MOU has been to develop and implement conjunctive use projects consistent with the 1996 GWMP. NFG has also participated in the BAP for purposes of updating the WMA B portion of this GWMP. NFG comprises Burrell Ditch Company, Crescent Canal Company, Liberty Canal Company, Liberty Mill Race Company, Reed Ditch Company, and Stinson Canal and Irrigation Company. Liberty, Laguna, and Riverdale IDs had previously produced GWMPs for their jurisdictions. The Riverdale ID and Laguna ID Board of Directors adopted resolutions to join the NFG in 2004 to create a larger and more representative hydrologic area and be covered under the GWMP.

Actions taken since adopting the 1996 GWMP include forming the NFG, developing the MOU with DWR, and construction of a number of local groundwater recharge projects. Under the MOU with DWR, a Basin Assessment Technical Memorandum was prepared (WRIME 2004) to document current groundwater conditions. At the request of the NFG at the November 2004 meeting, the technical memorandum also included a work plan to complete the data by conducting field investigations and for performing preliminary engineering feasibility studies and designs for recharge ponds. The NFG also requested that KRCD prepare grant applications for AB 303 grant funding. KRCD staff prepared and submitted a 2004–05 AB 303 grant application to conduct the hydrogeologic characterizations and preliminary engineering work.

WATER MANAGEMENT AREA C

The GWMP for WMA C was completed by KRCD in June 1998 and adopted on August 11, 1998. Although the area was not found to be in overdraft, the GWMP was adopted to develop a coordinated approach to the evaluation and management of groundwater. The report documented that WMA C has good availability of surface water supplies. This area is more geologically complex than WMAs A or B and has limited additional recharge potential in much of the region. Additional geologic studies and monitoring were recommended to confirm the presence of clay layers that would constrain direct-recharge projects, although the “in lieu” recharge historically practiced could potentially be expanded. With financial support provided by DWR, KRCD worked with local interests to support drilling exploration holes and constructing dedicated monitoring wells to characterize the aquifers, monitor levels in the confined aquifers to the south in WMA C, and provide important data to document the conclusions of the GWMP.

OTHER RELATED KRCD AND GWMP ACTIONS IN THE LOWER KINGS BASIN

Since adoption of the GWMPs for the Lower Kings Basin, KRCD has continued to implement actions to support the common objectives and recommendations of the plans. These actions were to:

- Use existing KRCD educational and public information programs to promote conjunctive use and groundwater management;
- Publish the 1999 report titled “Artificial Groundwater Recharge in the Kings River Service Area” to map and document ten groundwater recharge programs in the Kings Basin, including recommendations on how other areas can become involved in groundwater recharge programs;
- Expand the KRCD ambient groundwater level monitoring program;
- Produce annual groundwater reports; and
- Prepare applications for a range of grant funds.

RELATED GWMPs AND PLANNING EFFORTS

The Upper Kings Basin water districts include Alta Irrigation District (AID), Consolidated Irrigation District (CID) and Fresno Irrigation District (FID), all of which have prepared and are updating their GWMPs. CID and FID are up gradient from and directly abut the Lower Kings Basin GWMP planning area. The three districts also signed MOUs with DWR to support development of conjunctive use and groundwater recharge projects. A Basin Assessment Report (WRIME 2003a) and preliminary conjunctive use assessment report were produced under the MOU (WRIME 2003b).

This work led to the expansion of the group and formation of the Upper Kings Water Forum, whose purpose it is to develop an Integrated Regional Water Management Plan (IRWMP) through a collaborative effort involving the water districts, environmental interests, overlying cities and counties, and other stakeholders.

1.6 GWMP COMPONENTS AND CONSISTENCY WITH THE CALIFORNIA WATER CODE

Groundwater management is the planned and coordinated local effort of sustaining the groundwater basin to meet future water supply needs. With the passage of AB 3030 in 1992, local water agencies were provided a systematic way of formulating groundwater management plans (California Water Code, Sections 10750 et seq.). AB 3030 also encourages coordination between local entities through joint-power authorities or MOUs. SB 1938, passed in 2002, further emphasized the need for groundwater management in California. SB 1938 requires

AB 3030 groundwater management plans to contain specific plan components to receive state funding for water projects. The Lower Kings Basin GWMP includes the seven mandatory components that are required to be eligible for the award of funds administered by DWR for the construction of groundwater projects or groundwater quality projects. The GWMP also addresses the 12 specific technical issues identified in the California Water Code along with the seven recommended components identified in DWR Bulletin 118 (DWR 2003). Table 1.2 lists the required and recommended components and identifies the specific location within this GWMP where the information can be found.

Table 1.2. Lower Kings Basin GWMP Components

Description	Section(s)
<i>SB 1938 Mandatory Components</i>	
1. Documentation of public involvement	1.4, 1.5
2. BMO(s)	3.3
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality	4.2-4.4
4. Plan to involve other agencies located in the groundwater basin	1.5
5. Adoption of monitoring protocols	4.4, 6.5
6. Map of groundwater basin boundary, as delineated by DWR Bulletin 118, with agencies boundaries that are subject to GWMP	1.2
7. For agencies not overlying groundwater basins, prepare the GWMP using appropriate geologic and hydrogeologic principles	N/A
<i>AB 3030 and SB 1938 Voluntary Components</i>	
1. Control of saline water intrusion	4.4
2. Identify and manage well protection and recharge areas	4.4
3. Regulate the migration of contaminated groundwater	4.4
4. Administer well-abandonment and destruction program	4.4
5. Control and mitigate groundwater overdraft	4.2, 4.3
6. Replenish groundwater	4.2, 4.3
7. Monitor groundwater levels	4.4
8. Develop and operate conjunctive use projects	4.3
9. Identify well-construction policies	4.4
10. Develop and operate groundwater contamination cleanup, recharge, storage, conservation, water-recycling, and extraction projects	4.2-4.4
11. Develop relationships with state and federal regulatory agencies	6.3
12. Review land use plans and coordinate with land use planning agencies to	4.4

Description	Section(s)
assess activities that create reasonable risk of groundwater contamination	
<i>DWR Bulletin 118 Suggested Components</i>	
1. Manage with guidance of advisory committee	1.4
2. Describe area to be managed under GWMP	1.2
3. Create links between BMOs and goals and actions of GWMP	3.1, 4.1, 6.1
4. Describe GWMP monitoring programs	4.4
5. Describe integrated water-management planning efforts	4.4
6. Report of implementation of GWMP	6.3
7. Evaluate GWMP periodically	6.3

1.7 CONTENTS OF THE GWMP

The following provides a description for each section included in this GWMP.

Section 1 - Introduction: This section provides background information and context for the GWMP.

Section 2 - Water Resources Setting and Current Conditions: This sections is provided to help define the water supply and management problems to be addressed in the GWMP, and describes the baseline conditions to lay the foundation for establishing GWMP goals and objectives. It contains an overview of the physical setting, including the climate, soils, and geology and describes any major planning constraints. Also presented are current and future land use and water demands, water supplies and sources, existing water supply facilities, groundwater conditions, water quality, and water budgets for the Lower Kings Basin.

Section 3 - Goals and Objectives: This section contains the GWMP goals and objectives and the specific BMOs that were developed to help quantify the groundwater management goals and objectives, establish planning timeframes, define operational parameters, and set measurable targets that may be used by local stakeholders to measure progress or to "trigger" subsequent management responses. BMOs are set for each WMA related to stabilizing groundwater levels and for project development.

Section 4 - Groundwater Management Options: This section provides a description of each surface water and groundwater management option that was considered and discussed by the BAP. Other management options or program elements considered for inclusion in the Lower Kings Basin are also discussed, including the required or recommended elements pursuant to SB 1938. The BMO also sets set up the planning framework and priorities for interpreting the

near-term or long-term applicability of the option. The issues and constraints associated with each individual option were evaluated to determine the applicability and relation to the Lower Kings Basin GWMP; some options were rejected while others were carried forward to be integrated into and develop the GWMP components.

Section 5 - Financing and Governance Options: This section presents an analysis and description of alternative governance and financing options for managing and implementing the GWMP.

Section 6 - Management and Implementation Plan: This section provides information regarding the plan components and how the plan will be managed and implemented.

Section 7 - References

This section summarizes the groundwater and water supply problems and issues that are addressed in the GWMP. It describes the historical and baseline conditions and contains an overview of the physical setting, including the climate, soils, and geology and describes the major planning constraints in these resource categories. Current and future land use and water demands, groundwater conditions, water supplies and sources, existing water supply facilities, and water quality in the Lower Kings Basin are presented.

2.1 SCOPE AND APPROACH

Historical groundwater and surface water data were collected and inventoried to support the GWMP update, document problems, and identify potential solutions. Existing hydrologic data, maps, and related water resources reports were compiled and inventoried from local, state, and federal data sources in both digital and hard copy formats.

Site meetings with KRCD staff and water agency representatives were held to obtain available data and maps, review existing facilities and operations, discuss opportunities for developing new facilities, and document potential options and GWMP components. The primary issues, stakeholder interests, expectations, and objectives were also discussed to identify areas of concern and consensus within the Lower Kings Basin.

Previous reports were reviewed and the available data analyzed to document the historical and existing conditions of the groundwater basin and to identify unique characteristics within each Area. This included calculating existing water demands and forecasting future demands using data related to land use, unit water requirements, and the different crop types in the Lower Kings Basin. Groundwater data were analyzed to evaluate trends, document changes in storage, assess groundwater occurrence and flow conditions, and determine available groundwater storage space that might be used for conjunctive use. Composite hydrographs were prepared for each WMA and used to forecast future water level conditions and help the BAP establish BMOs. The results of the analyses were used by the BAP to gain a consensus on the nature and extent of the problem before establishing GWMP goals, general objectives, and the specific BMOs that are presented in Section 3.

The data and results of the analyses are summarized in this section, and the more detailed data and results are provided in the appendices.

2.2 PHYSICAL SETTING

Surface and subsurface conditions influence groundwater management options. Local soils and near surface conditions influence how water applied at the land surface, either from rainfall or irrigation, moves through the soil and percolates downward into the groundwater basin; how canal flows and stream flow contribute to the groundwater budget; and also may influence the location and design of recharge projects and delivery canals. Deeper geologic features control the fate and transport of water once it is in the subsurface, groundwater storage capacity, recharge–discharge relationships, flow between areas, and well designs and pumping rates.

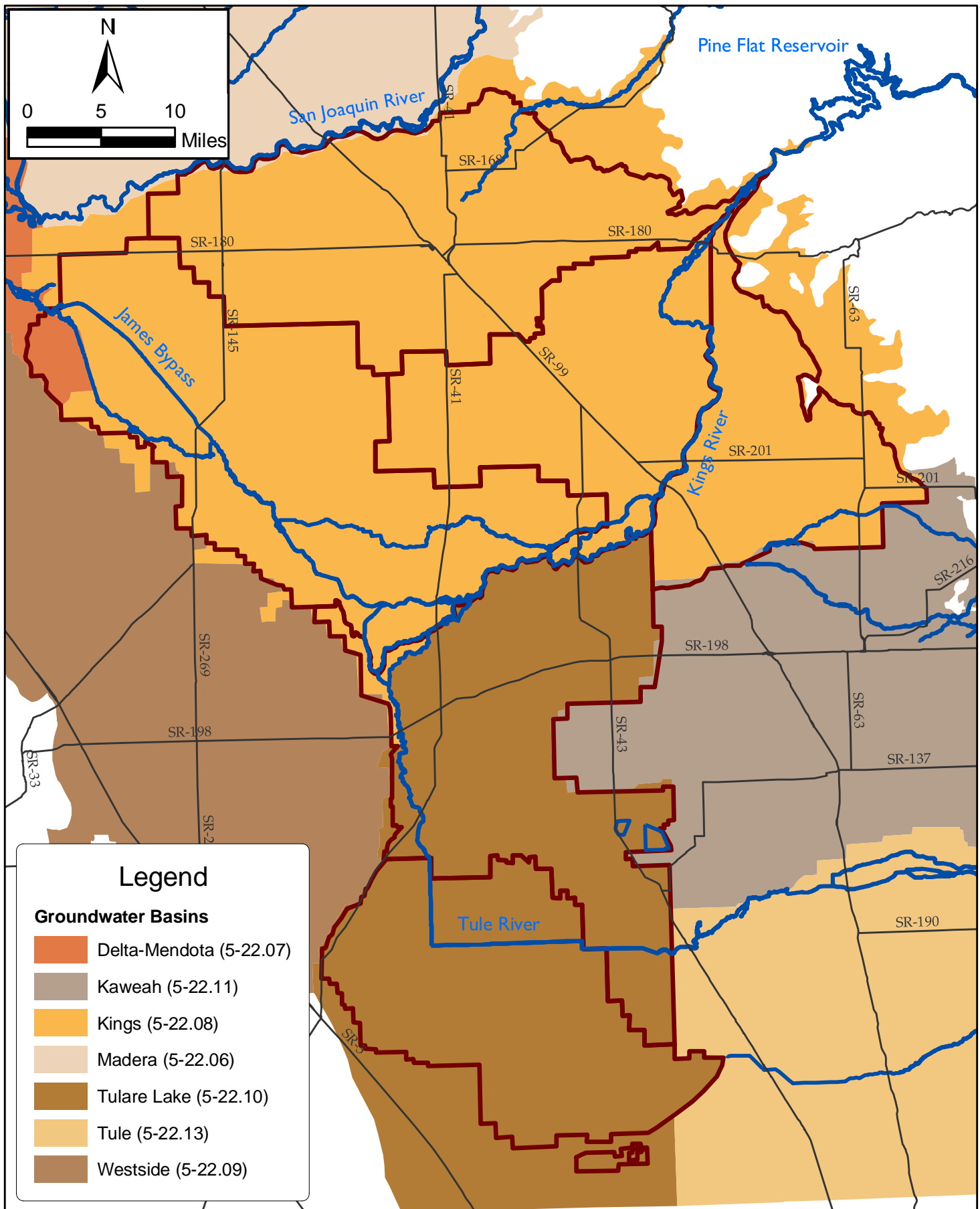
GROUNDWATER BASIN

Figure 2.1 presents a map showing the area of the Kings Subbasin (DWR basin no. 5-22.8) and surrounding groundwater basins as defined by DWR (DWR 2003). The San Joaquin and Kings Rivers are the two principal rivers within or bordering the subbasin.

The Kings Subbasin underlies an area of approximately 1,530 square miles and is part of the San Joaquin Valley Groundwater Basin. It is bounded on the north by the San Joaquin River, which is a source of recharge to both the Madera and Kings Subbasins. There are no geologic features or faults that would prevent water from flowing between the Madera and Kings Subbasins. The western boundary of the Kings Subbasin is defined by the eastern boundaries of the Delta-Mendota and Westside Subbasins. Groundwater can also move between the Delta-Mendota and Westside Subbasins and the Kings Subbasin.

The southern Kings Subbasin boundary runs easterly along the northern boundary of the Empire West Side ID, the southern fork of the Kings River, the southern boundary of Laguna ID, the northern boundary of the Kings County WD, the southern boundaries of CID and AID, and the western boundary of Stone Corral ID. The Kaweah and Tulare Lake Subbasins are to the south and the flow relationships between the Kings Subbasin and these subbasins are less well defined. The eastern boundary of the Kings Subbasin is the alluvium-granitic rock interface of the Sierra Nevada foothills.

The Lower Kings Basin is a locally defined planning area based primarily on surface water management and jurisdictional boundaries. The Lower Kings Basin is also defined by hydrogeology since the Lower Kings Basin has unique groundwater recharge and discharge characteristics. These characteristics will be discussed later in the document. The Lower Kings Basin extends from the western boundaries of FID, CID, and Kings County WD. It is bounded on the north by the San Joaquin River and on south by the southern boundary of Stratford ID.



Lower Kings Basin GWMP Update

Groundwater Basins

April 2005

Figure 2.1

The Upper Kings Basin has a total groundwater storage capacity of 35 million acre-feet to an average depth of about 500 feet (KRCD, 1993). DWR estimates groundwater storage for the entire Kings Basin as 95 million acre-feet to a depth no more than 1,000 feet (DWR Bulletin 118-03). Groundwater storage in the Lower Kings Basin is estimated in this report as 44 million acre-feet to a depth of 1,000 feet. The Lower Kings Basin storage estimate was calculated by multiplying the area of the Lower Kings Basin, the depth of 1,000 feet and the average specific yield of the Lower Kings Basin which was estimated as 12.3%. The total volume of groundwater storage in the Lower Kings Basin, though sizable, is not all useable due to both economical and technical reasons that include increased pumping costs due to deepening groundwater levels and excessive lifts; the possibility to of causing the migration of poor quality water; and the potential to induce land subsidence.

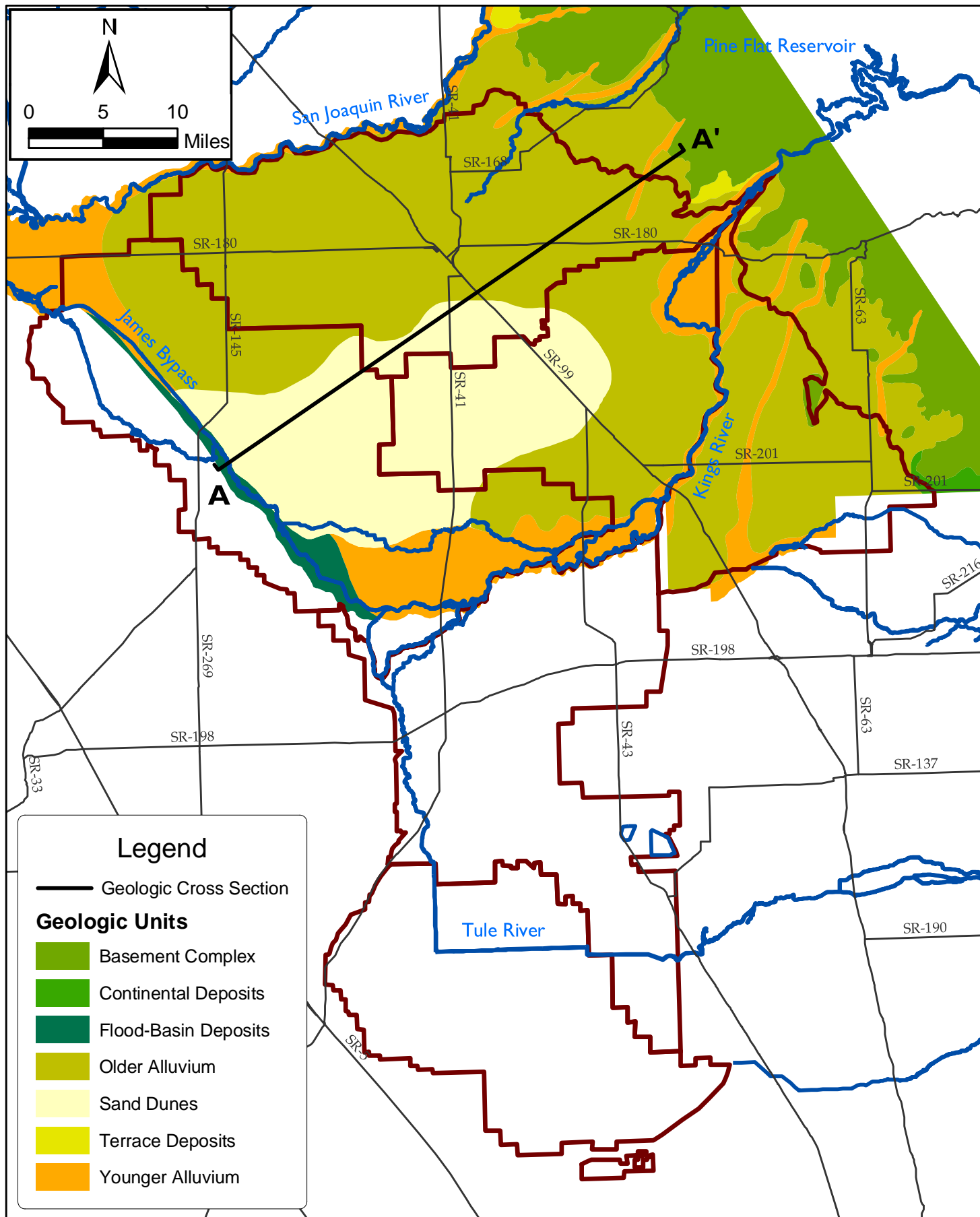
BASIN TOPOGRAPHY

The Kings River watershed covers an area of 1,742 square miles, with the majority being east of the Lower Kings Basin. The watershed includes a portion of the Sierra Nevada mountains with elevations ranging from 500 to 14,000 feet above mean sea level (msl). A large percentage of the watershed lies above an elevation of 5,000 feet, and as such, winter snow pack is the most important source of water storage in the Kings River. There is little change in ground surface elevation in the Lower Kings Basin. Ground surface elevations are the highest on the east side of the Lower Kings Basin and gradually decline to the west toward the axis, or lowest part of the San Joaquin Valley, ranging from 150 to 270 feet above mean sea level.

GEOLOGY

The Lower Kings Basin groundwater aquifer system consists of unconsolidated continental deposits (DWR, 2003). The deposits are divided into formations that include older alluvium, marsh deposits, younger alluvium, and flood-basin deposits. The older alluvium is an important aquifer that readily yields water to wells. It consists of lenses of clay, silt, sand, gravel, cobbles, and boulders and is generally fine grained near the deepest part of the valley. Marsh deposits are mixed in with the older alluvium in the Lower Kings Basin. The younger alluvium is a sedimentary deposit found beneath the river channels and is highly permeable. The flood-basin deposits consist of sand, silt, and clay and occur along Fresno Slough and James Bypass. There are no known major faults or fault zones that have been mapped or identified that would inhibit groundwater flow within the Lower Kings Basin, or between the Lower Kings Basin and surrounding areas.

Figure 2.2 shows the surface geology of the Lower Kings Basin and indicates the location of a geologic cross section presented in Figure 2.3. The western portion of the cross section shows

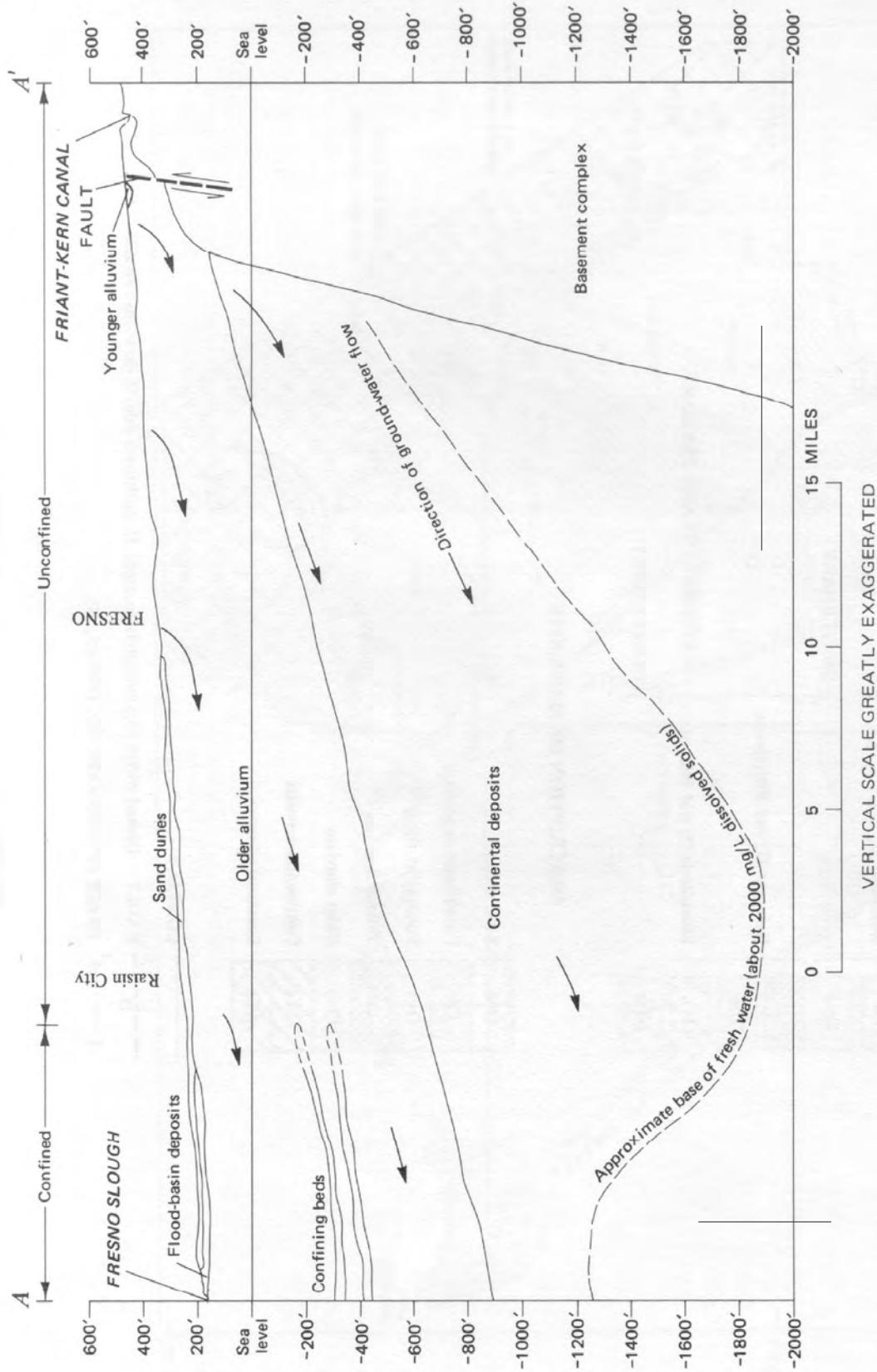


Lower Kings Basin GWMP Update

Surface Geology and Geologic Cross Section

April 2005

Figure 2.2



Source: USGS. 1977, *Groundwater in the Fresno Area*,
Water Resources Investigations 77-59.



Lower Kings Basin GWMP Update Representative Geologic Cross Section

April 2005

FIGURE 2.3

the relationship between geologic units below the surface in the Lower Kings Basin. The figure is illustrative of the clay layers that are present in the Lower Kings Basin. The presence of these clay layers influence conjunctive use and are a factor in locating potential recharge project facilities.

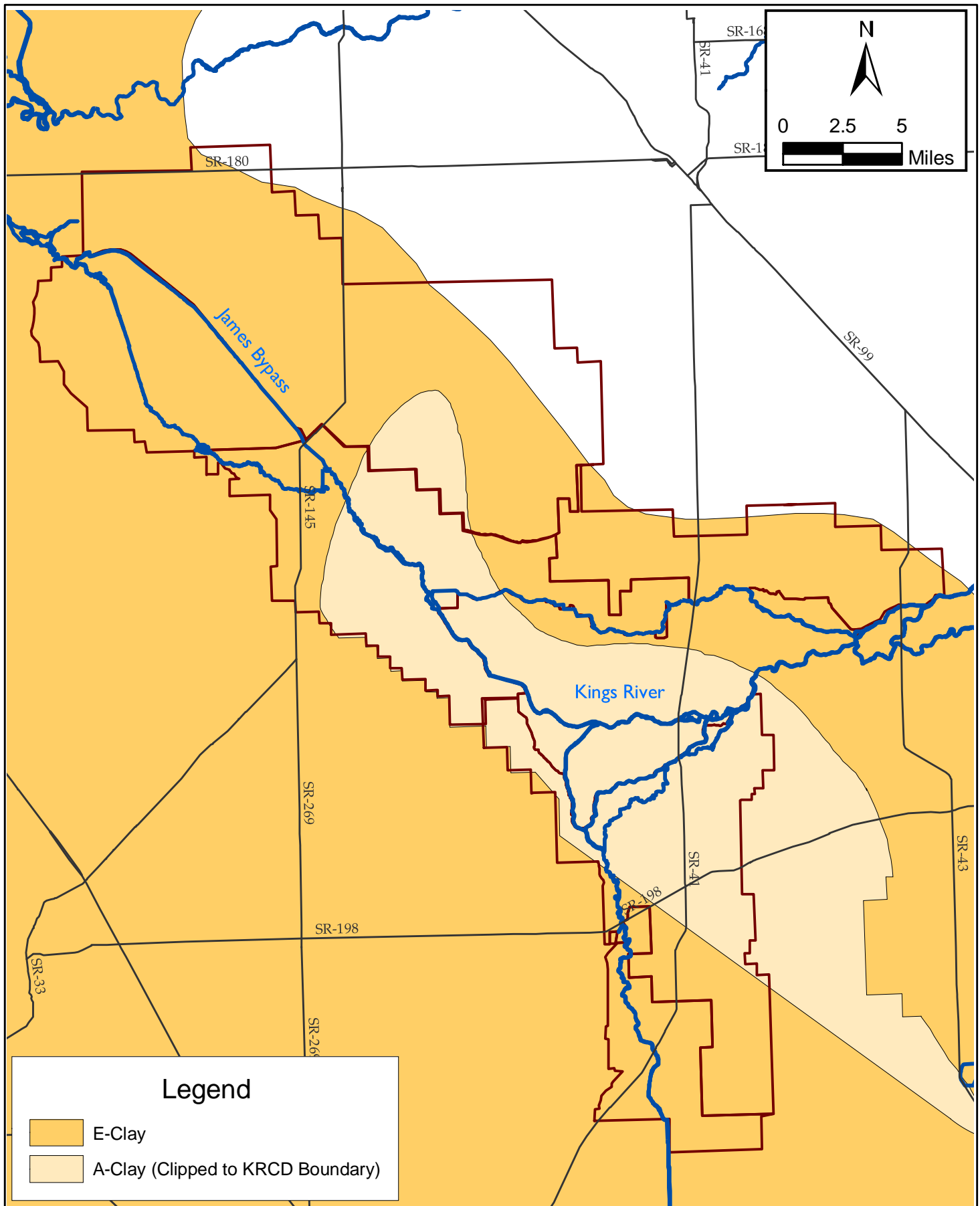
The impermeable clay layers extend throughout much of the Lower Kings Basin, as shown in Figure 2.4. Impermeable and nearly impermeable clay layers are present in the western and southern parts of the Lower Kings Basin and influence where water can be recharged and stored in the groundwater basin. The two most important layers are the A-Clay and E-Clay, which are present throughout much of the Lower Kings Basin. These clay layers are associated with flood and marsh deposits of the San Joaquin Valley lowlands and the Tulare Lake Bed. The clay layers interfinger with alluvial deposits of the valley. The aquifers beneath the clay layers are confined and under pressure. The presence of the confining clay layers also means that sands and gravels that make up the aquifer are not in direct connection with the land surface or potential sources of recharge. As a result, recharge to replace water removed by wells must enter the aquifer from sources up gradient of the pumping wells where the clays become discontinuous. This is the area in the eastern edge of the Lower Kings Basin. The presence or absence of these clay layers is a determinant for siting recharge projects and for evaluating the impacts or benefits of projects and pumping.

Typically, wells in confined aquifer are less susceptible to contaminants that originate at the land surface directly above the area of influence for a well, than are wells screened in semi-confined or unconfined aquifers. In the Lower Kings Basin, the implication is that cities relying on groundwater that are located above clay layers should construct wells in and below the clay layers to lessen the likelihood of contamination. All wells should be constructed with adequate seals between the formations to prevent the downward migration of poor quality water.

Site specific surface, near surface, and subsurface geologic conditions will be evaluated more extensively as part of engineering feasibility studies conducted for specific recharge projects. The specific projects being considered are discussed in Section 4.

LAND SUBSIDENCE

Land subsidence results from excessive groundwater pumping beneath laterally extensive confining clay layers. The removal of the groundwater from the confined aquifer causes increased pressure on the aquifer system located below the confining layer. This results in compaction of the fine-grained layers at depth, and is evident at the ground surface as land subsidence. Up to 6 feet of land subsidence occurred along the western edge of the Kings Basin between 1926 and 1970 (Ireland, 1984). During meetings held with Laguna ID staff, it was indicated that poured-in-place concrete pipes have cracked in unusual patterns and well heads



Lower Kings Basin GWMP Update **Impermeable Clay Layers**

Source: USGS PP 1401-D, 1989

April 2005

Figure 2.4

have separated from the ground surface in western most part of WMA B1. This may be indication of localized land subsidence and warrants further investigation and analysis.

SOILS AND SURFACE RECHARGE POTENTIAL

Surface recharge potential in the Lower Kings Basin is a function of soil type. The surface recharge potential of the soil was interpreted based on the hydrologic soil group, as categorized by the Natural Resources Conservation Service (NRCS). Hydrologic soil groups are classified according to their ability to infiltrate water and affect runoff. The soils are grouped according to the amount of water infiltration when the soils are thoroughly wet and receive additional precipitation. The four hydrologic soil groups are:

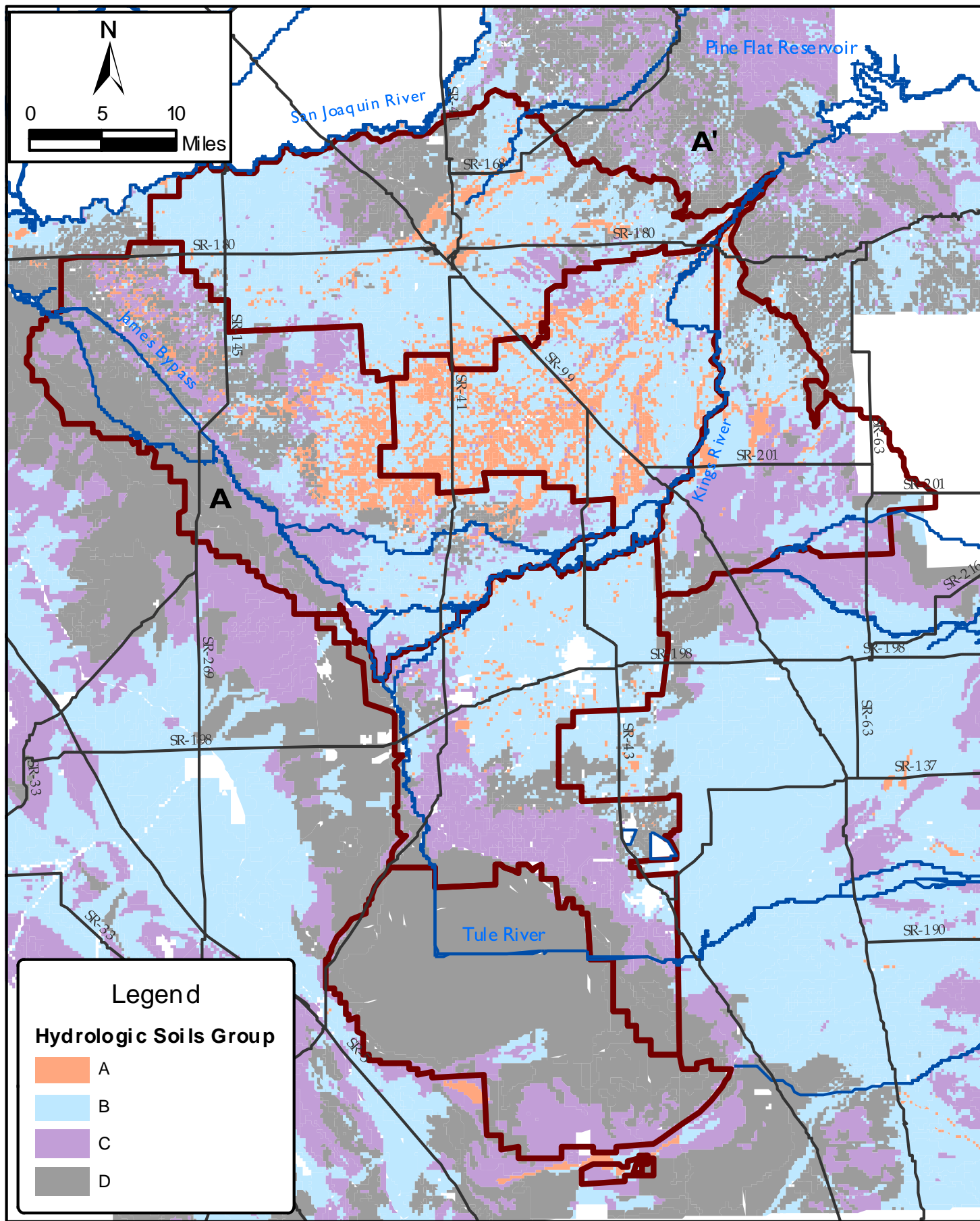
- **Group A:** Soils having a high infiltration rate (low runoff potential) when thoroughly wet;
- **Group B:** Soils having a moderate infiltration rate when thoroughly wet;
- **Group C:** Soils having a slow infiltration rate when thoroughly wet; and
- **Group D:** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet.

Figure 2.5 shows the hydrologic soil groups in the Lower Kings Basin. In general, Group A soils (i.e., those with the highest infiltration rate) are located along stream and river channels while Group B soils are widespread throughout the Lower Kings Basin. This indicates that soil type is not a major constraint for locating recharge projects. Site specific conditions will be further evaluated as part of a more detailed engineering feasibility study.

2.3 LAND USE AND WATER DEMAND

Water demands vary by land use and crop type. This section summarizes current and future land and water demands. Appendix C contains more detailed data and analysis results.

Current land use and water demands were analyzed using the 1999-2000 DWR land use surveys for Fresno, Kings, and Tulare Counties. Future land use and water demand were developed using estimates of expected land use in 2030. Figure 2.6 shows the generalized land use in the Lower Kings Basin. The figure includes delineation of urban areas as they currently exist and their projected spheres of influence (SOIs). Water duty factors were assigned for each type of land use and for the specific crop types and crop mix found in the Lower Kings Basin. Figure 2.7 shows current and projected land use and water demand in the Lower Kings Basin. More detailed crop maps were used for determining agricultural water demand and these maps

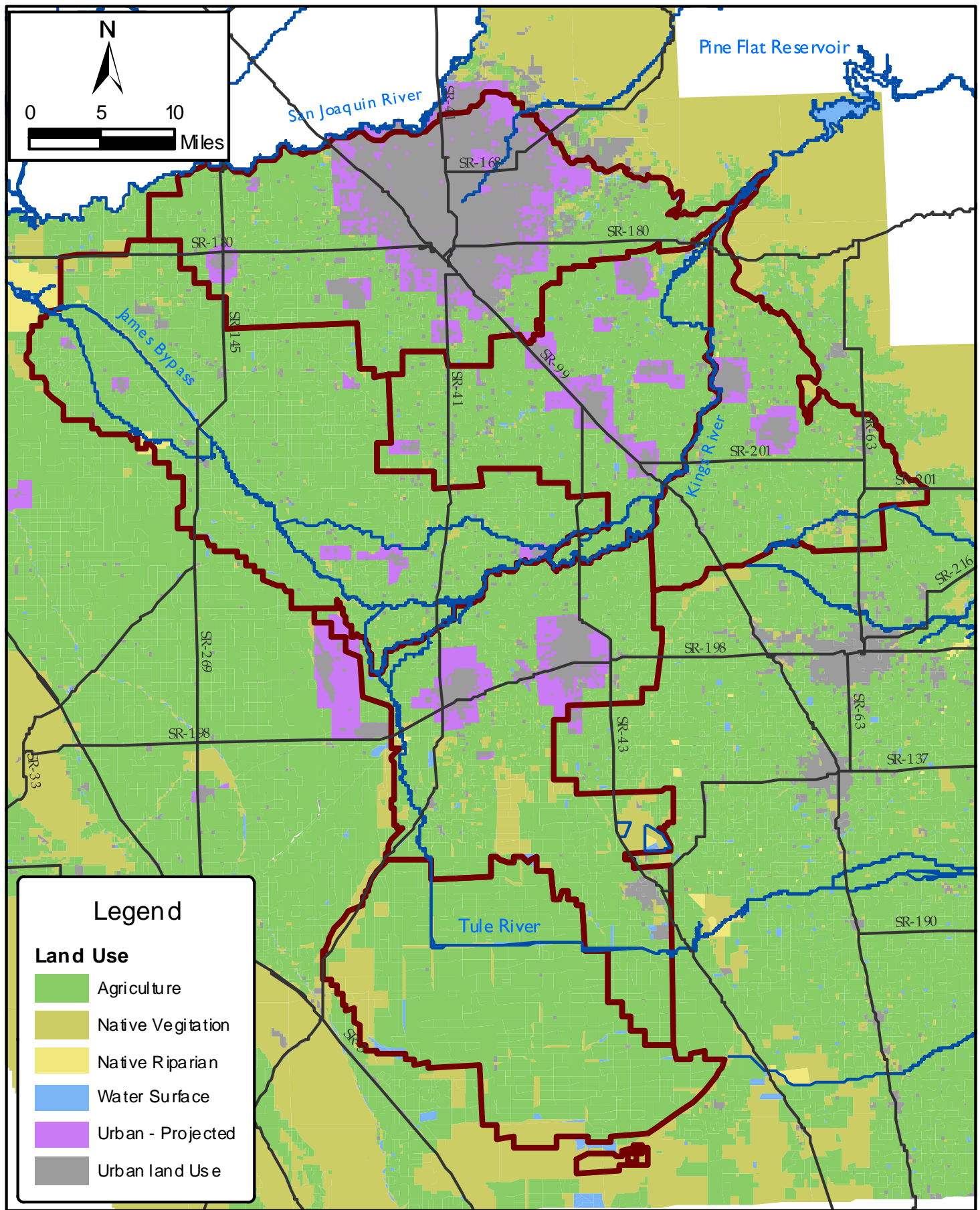


Lower Kings Basin GWMP Update

Hydrologic Soils Group

April 2005

Figure 2.5



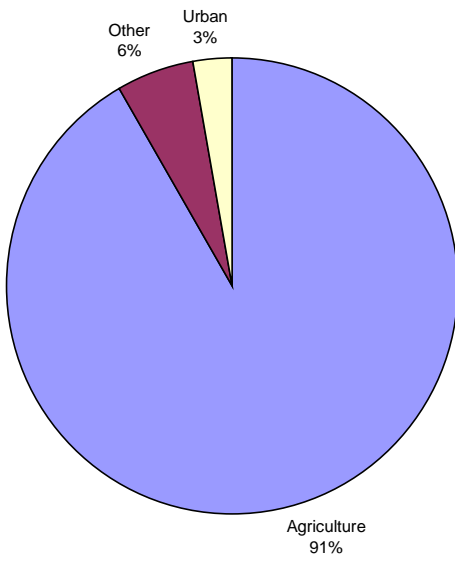
Lower Kings Basin GWMP Update

General Land Use

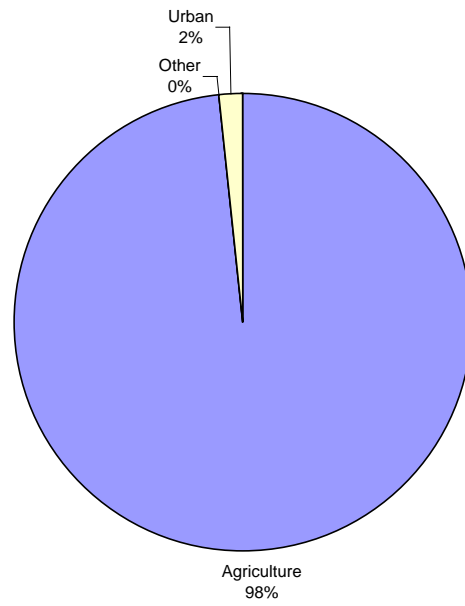
April 2005

Figure 2.6

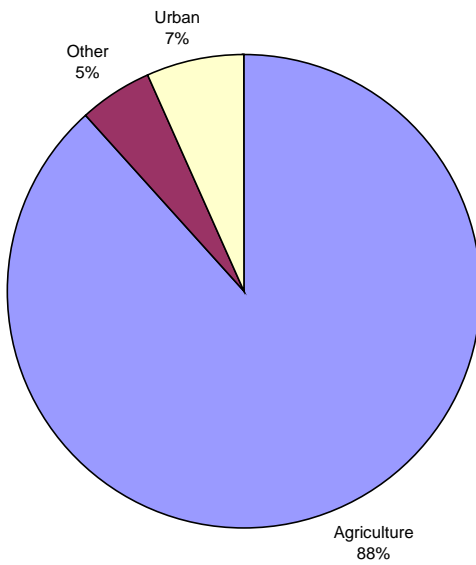
Current Land Use (Acres)



Current Water Demand (Acre-Feet)



Projected Land Use (Acres)



Projected Water Demand (Acre-Feet)

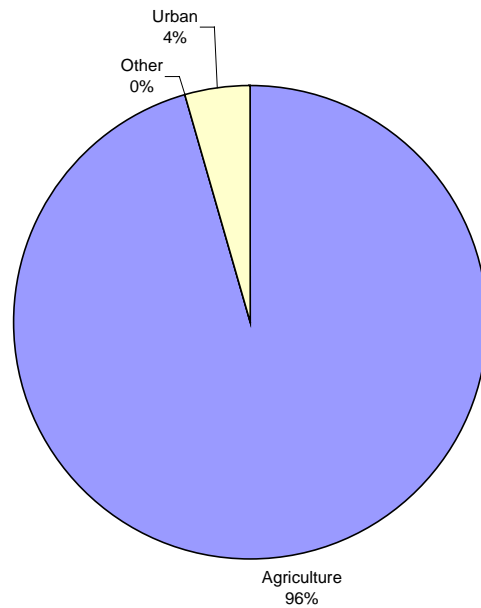


Figure 2.7 Summary of Land Use and Water Demand in Lower Kings Basin

are presented in Appendix C. Table 2.1 summarizes water demand and land use data for each WMA.

Table 2.1. Summary of WMA Demands and Land Use

WMA	Current Conditions					Projected Conditions				
	Agri-culture (Acres)	Other (Acres)	Urban (Acres)	Total (Acres)	Water Demand (AF)	Agri-culture (Acres)	Other (Acres)	Urban (Acres)	Total (Acres)	Water Demand (AF)
A	104,960	4,899	2,408	112,268	321,133	104,552	4,899	2,816	112,268	320,878
A1	36,644	1,275	788	38,707	118,647	36,197	1,269	1,241	38,707	118,010
B	56,533	2,600	725	59,858	161,898	56,414	2,600	844	59,858	161,839
B1	48,796	3,493	1,810	54,099	158,880	45,061	3,158	5,880	54,099	155,060
B2	33,800	283	375	34,459	108,433	33,800	283	375	34,459	108,433
C	46,542	6,100	4,686	57,328	147,854	39,757	4,480	13,091	57,328	142,517
C1	18,641	2,070	372	21,083	50,187	18,641	2,070	372	21,083	50,187
Total	345,918	20,720	11,164	377,802	1,067,032	334,423	18,760	24,619	377,802	1,056,923

Approximately 92% of the Lower Kings Basin is in agricultural use and 3% is in urban use under current conditions. Remaining 5% of land area is undeveloped. Agricultural water demand in the Lower Kings Basin was estimated to be 98% of total water demand (total water demand is approximately 1,067,000 acre-feet).

Projected land use and water demand data were developed for 2030 conditions. The primary change in land use is the conversion of agricultural lands to urban development near or adjacent to existing cities and towns. The Lower Kings Basin contains relatively small urban areas that include cities of San Joaquin (WMA A1), Riverdale (WMA B1), Lemoore (WMA C), Raisin City (WMA A), Lanare (WMA B1), Laton (WMA B1), and Tranquility (WMA A1). The cities and county define their growth plans in the most recent general plan. The projection was based on information obtained from local land use planning agencies and the Fresno County Local Agency Formation Commission (LAFCO). The Fresno County LAFCO works with the cities and county to establish a SOI that defines a boundary for urban growth.

For projected agricultural land use conditions, the current crop mix was assumed to remain unchanged from current conditions. Based on the analysis of projected land use data, the agricultural area is expected to be reduced by approximately 11,500 acres and the urban area is expected to increase by 13,500 acres. The increase in urban area includes the development of previously undeveloped lands. The change in land in use represents a 4% reduction in total agricultural area and increase of 120% in urban development from current conditions.

There is corresponding change in water demand with the changes in land use. Future agricultural water demand for the Lower Kings Basin is estimated to be 96% of the total water

demand of 1,057,000 acre-feet. It is expected that the total water demand for the Lower Kings Basin will decrease slightly from current conditions.

CLIMATE-PRECIPITATION AND EVAPOTRANSPIRATION

The climate in the Lower Kings Basin is semi-arid, with mild winters and hot, dry summers. Typical annual rainfall is 8–11 inches per year, with most of the rainfall occurring in winter and spring. Figure 2.8 shows the average monthly distribution of precipitation at Fresno Yosemite International Airport, which, because of its location, is representative of the Lower King Basin. Figure 2.8 also shows the average monthly reference evapotranspiration (ET) at the Fresno State California Irrigation Management Information System (CIMIS) station. Reference evapotranspiration is used by growers to determine crop water needs and schedule irrigation. Water use of specific crops varies, but reference ET provides a good general measure of crop water demands.

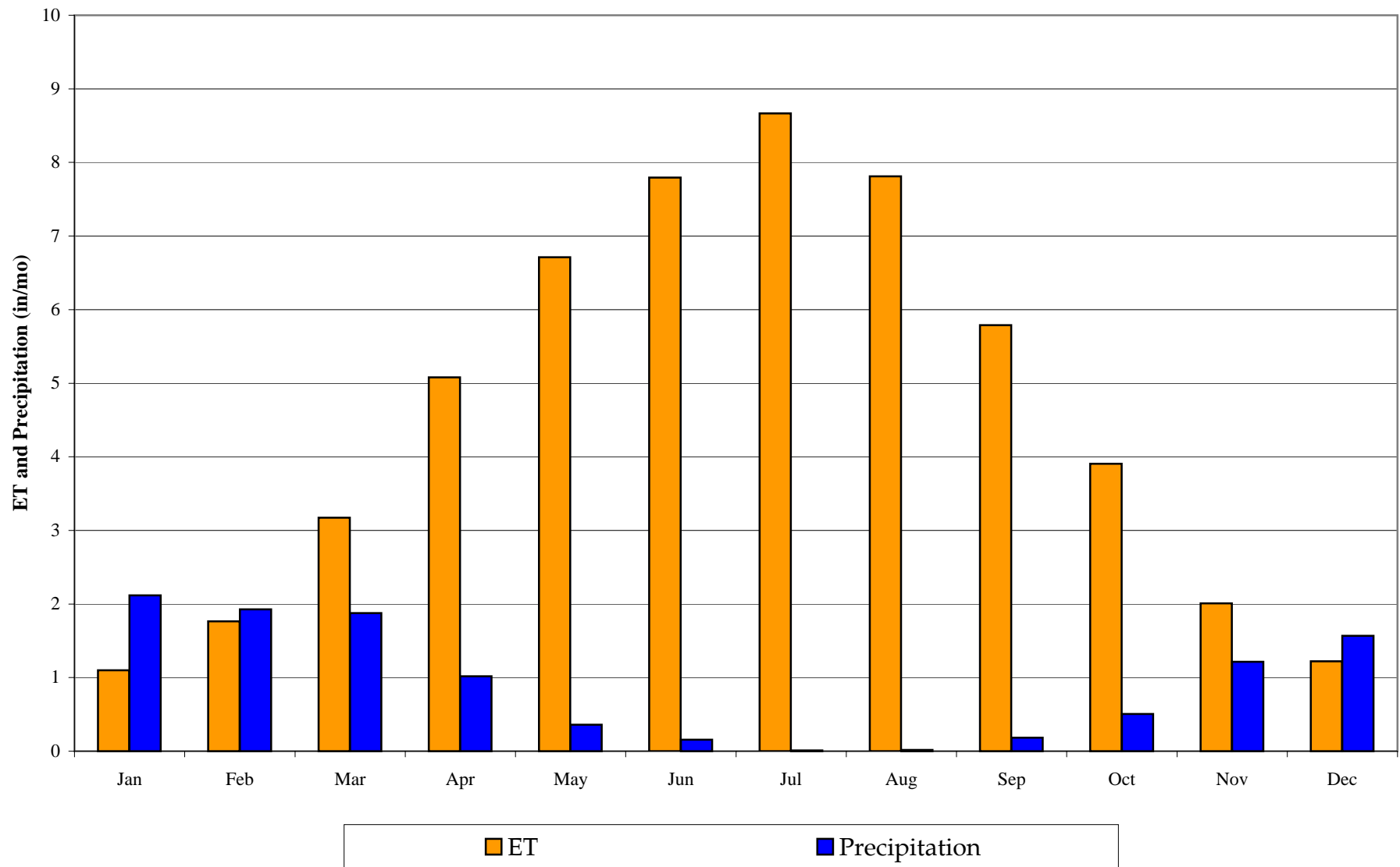
Figure 2.8 shows that precipitation in the Lower Kings Basin does not provide water for crops at times or in the amounts needed to meet crop water demands. The difference between precipitation and ET represents the crop water demand that must be met with applied water. In the Lower Kings Basin this applied water is either delivered surface water or pumped groundwater.

2.4 GROUNDWATER CONDITIONS AND SUPPLIES

Groundwater is used to meet all of the urban demands in the Lower Kings Basin. Groundwater pumping for agricultural use varies as a function of crop water requirements, hydrologic variability, surface water rights, and access to facilities to deliver water.

Within WMA A, there are no surface water delivery facilities and the area does not have water rights to the Kings River or San Joaquin River. Overlying land owners have groundwater rights and are dependent on groundwater to meet 100% of crop water demands. This is also the case in some parts of WMAs B, B2, and C.

Within much of WMAs B, B1, B2, and C, groundwater is used to meet crop water requirements at times when surface water deliveries are not available. The surface water deliveries are derived from water rights and entitlements from the Kings River.



Lower Kings Basin GWMP Update

**Average Monthly Reference Evapotranspiration (ET) at the Fresno State CIMIS Station &
Average Monthly Precipitation at Fresno Yosemite International Airport**

April 2005

FIGURE 2.8

GROUNDWATER LEVELS WITHIN THE WMAS

Groundwater levels in the Lower Kings Basin are monitored by growers, water districts, DWR, and KRCD (KRCD, 2005). Groundwater levels change in response to changes in groundwater recharge, discharge, and extraction. Figure 2.9 shows the location of wells with water level data in the Lower Kings Basin that were used to assess groundwater trends for GWMP. Data vary in quality and accessibility, but there are an adequate number of wells and data available to describe the historical trends and current conditions. Groundwater level changes were evaluated for each WMA by developing a representative groundwater level hydrograph, as described in Appendix D. Figures 2.10 through 2.16 shows the WMA aggregated hydrographs and simple statistical groundwater level trend line from 1950 through 2004. The trend line is an “inverse fit” curve and was determined to be the most accurate representation of the groundwater trends in the area and the best fit to the data. The hydrographs show that for all the WMAs, except WMA C, groundwater levels have steadily declined since 1964, even after construction of the Pine Flat Reservoir in 1954.

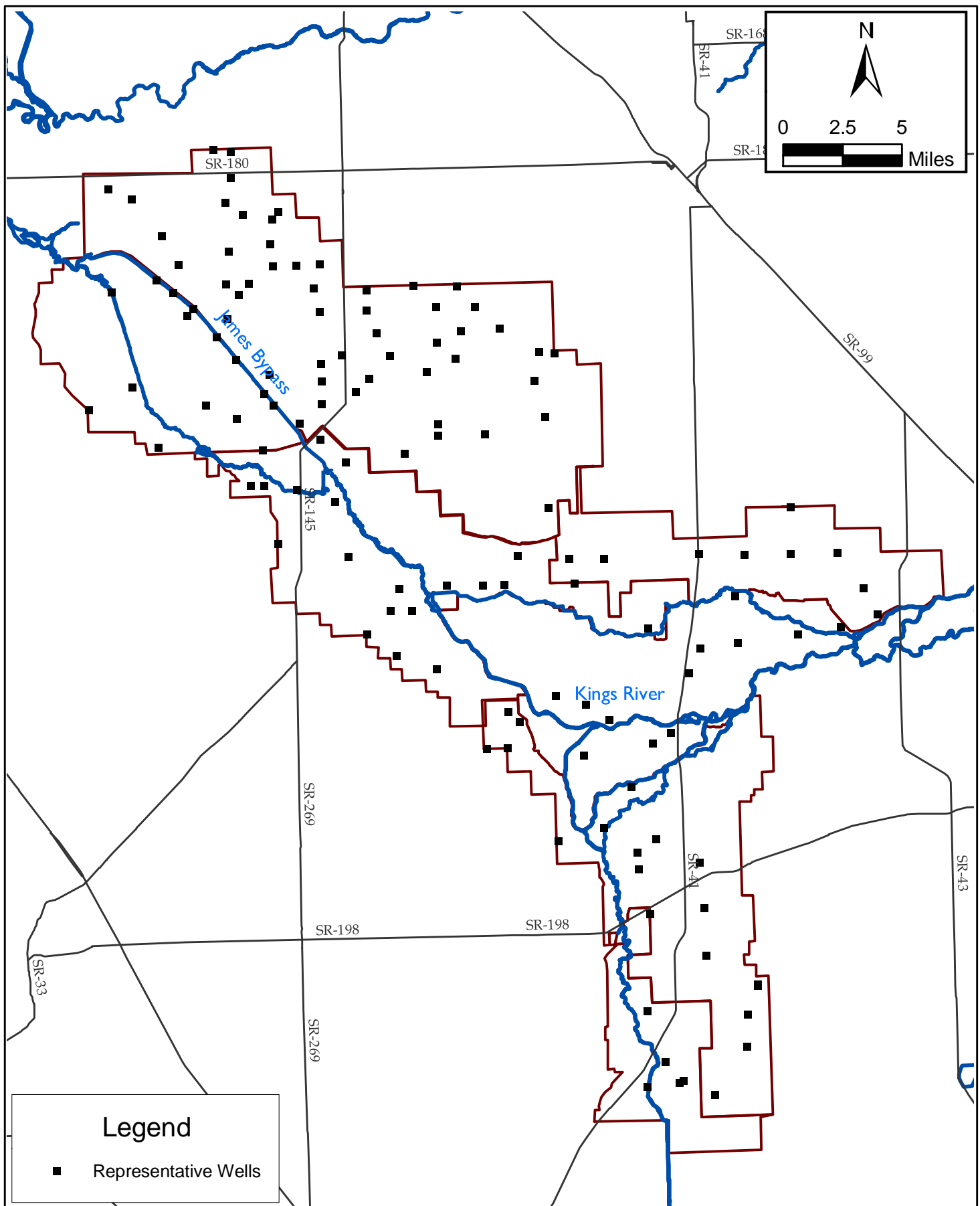
Groundwater levels are responsive to flow conditions in the Kings River and the overall hydrology of the basin; however, it is clear that the groundwater system is pumped at rate greater than that of groundwater recharge. It can be interpreted from the groundwater level trend lines that groundwater levels will continue to decline into the future should there be no changes in current operations and management. The reliance on groundwater to meet demands is causing the slow depletion of groundwater storage. The water level contours for the Lower Kings Basin also demonstrate the changes in storage over time.

GROUNDWATER OCCURRENCE, FLOW, AND CHANGES IN STORAGE

Groundwater table contour maps show lines of equal water level elevations. These maps are used to show the occurrence and movement of groundwater in the Lower Kings Basin. Groundwater table contour maps can also be used to evaluate the changes in storage between two time periods.

Figure 2.17 shows groundwater elevation contours for spring 2000. The figure shows the general regional flow patterns and recharge/discharge relationships in the Lower Kings Basin and was developed from data supplied by KRCD (KRCD, 2005). Appendix D contains other water table maps for different time periods over the past 50 years.

The primary regional groundwater flow pattern is from east to west. The highest groundwater levels are located along the eastern boundary of the Lower Kings Basin at about 240 feet above msl, and the lowest groundwater elevations are located at Raisin City at about 10 feet above

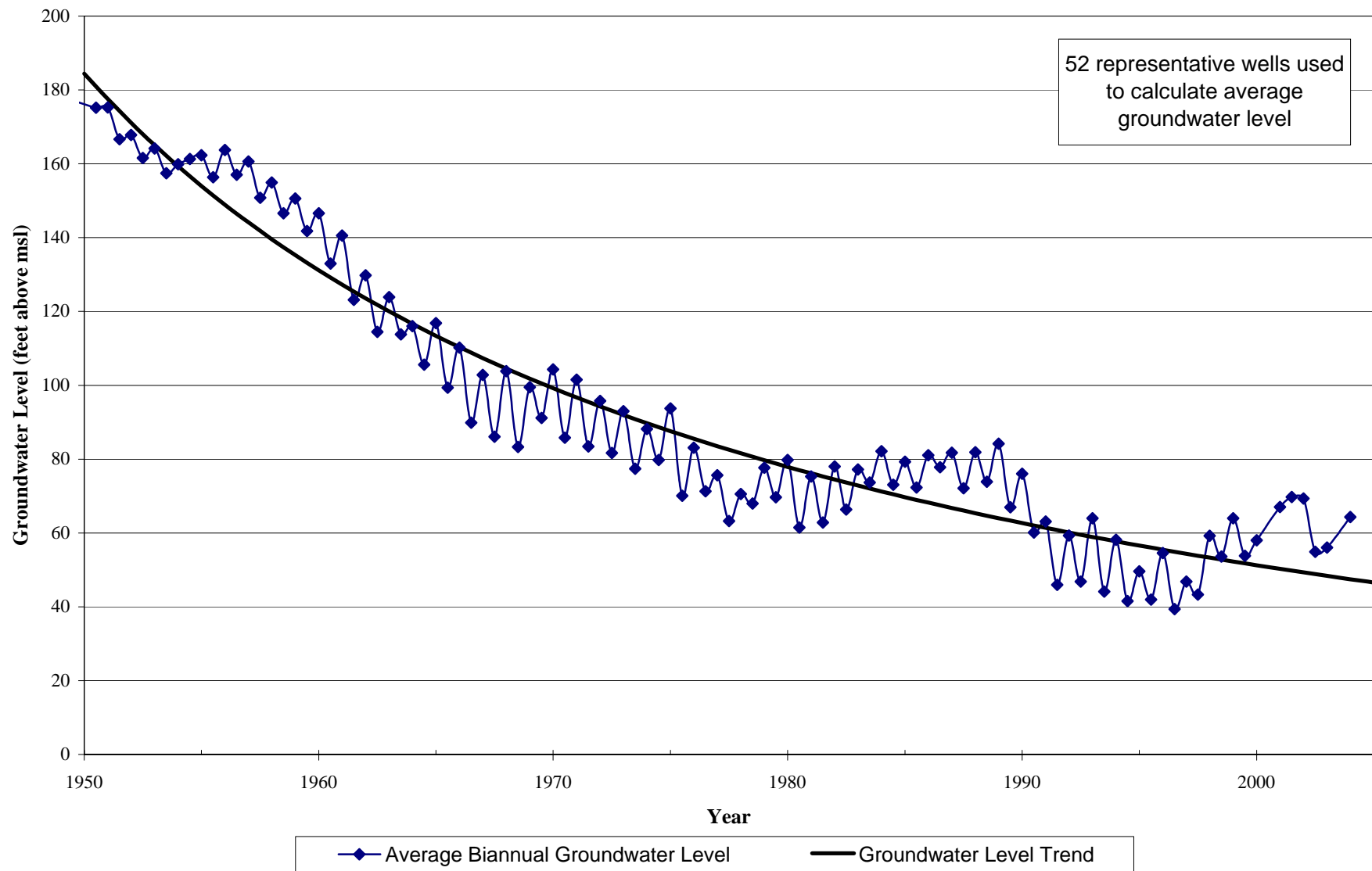


Lower Kings Basin GWMP Update

**Location of Representative
Groundwater Wells**

April 2005

Figure 2.9

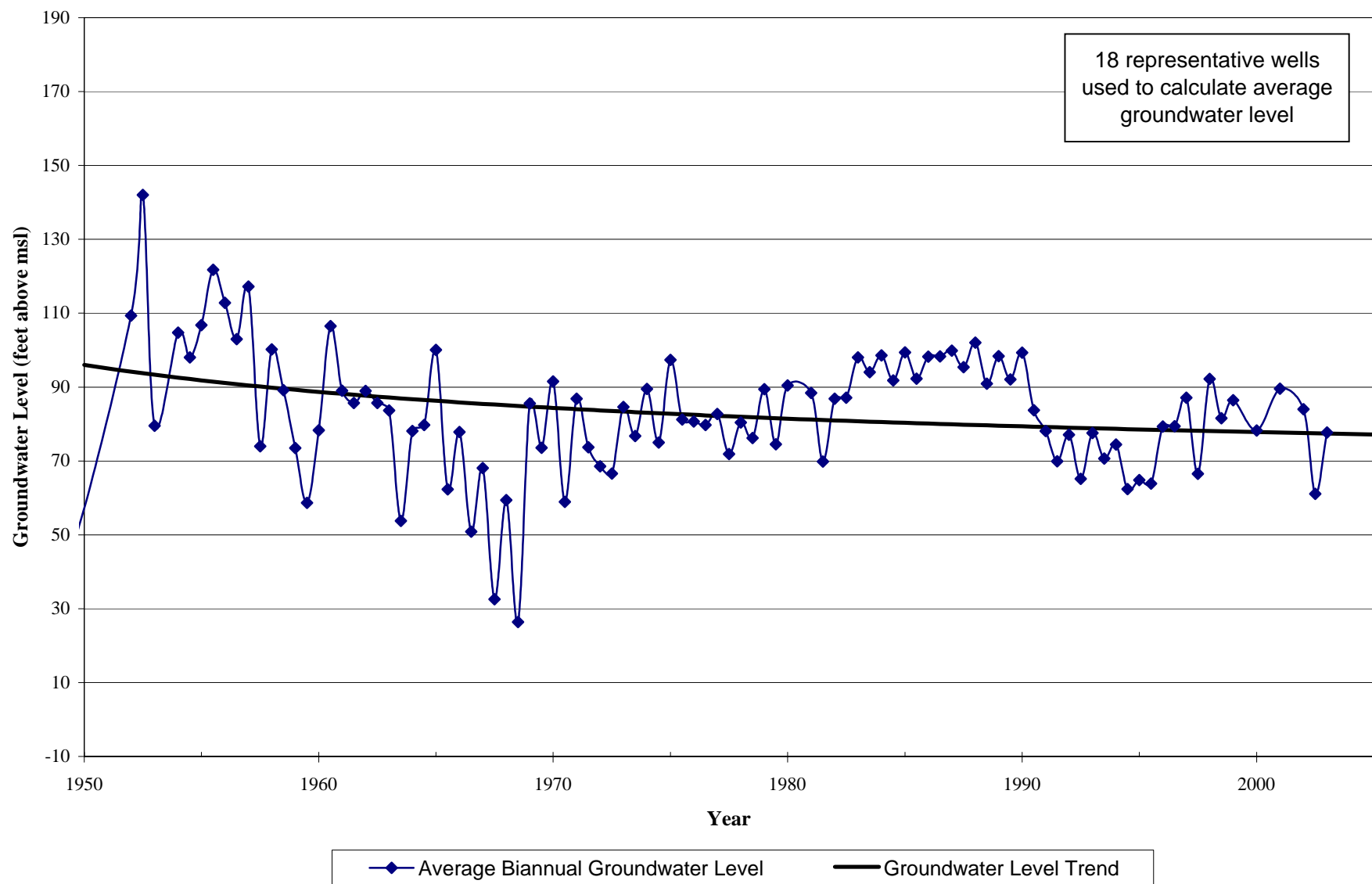


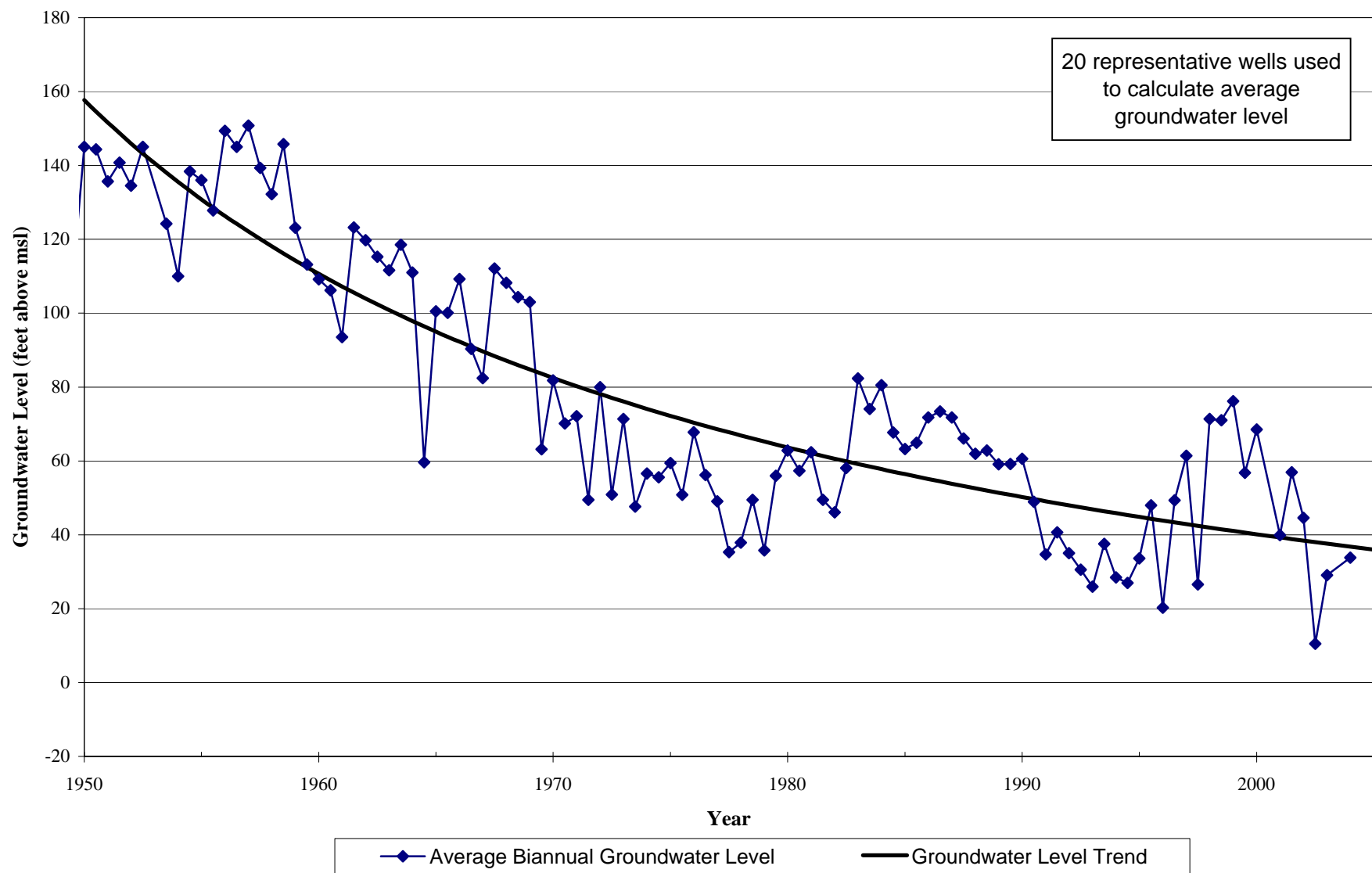
Lower Kings Basin GWMP Update

Groundwater Trends for WMA A

April 2005

FIGURE 2.10



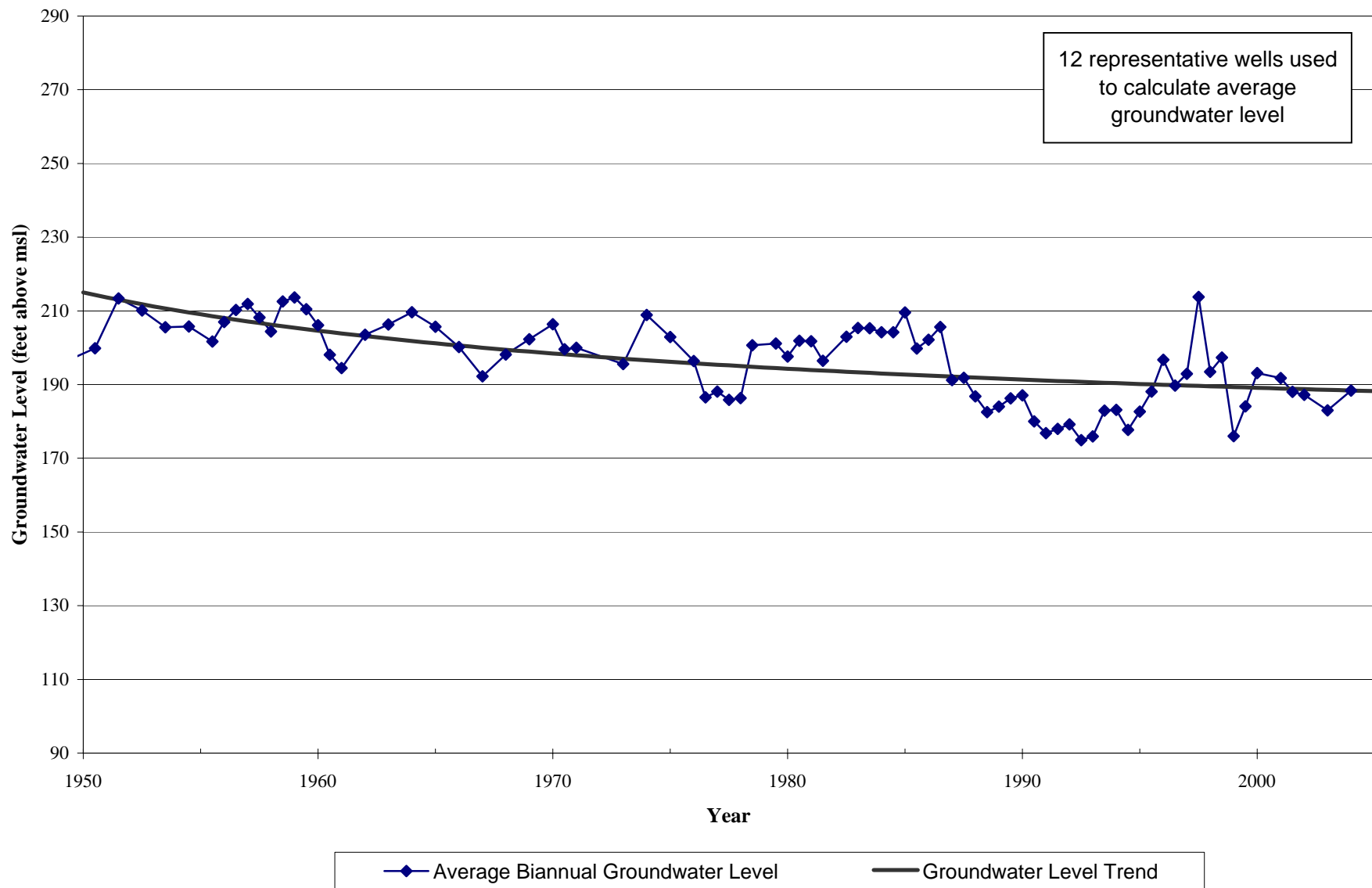


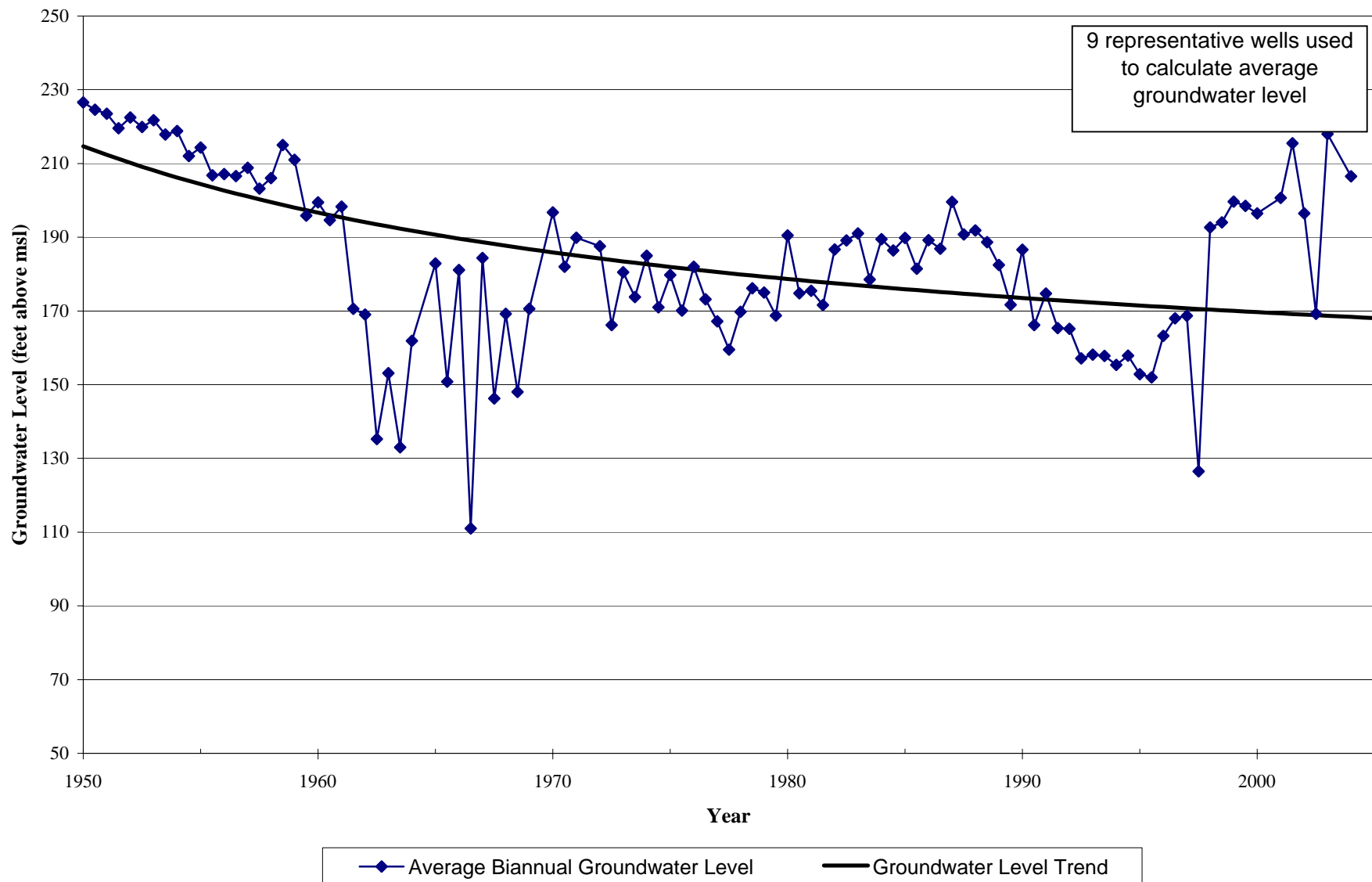
Lower Kings Basin GWMP Update

Groundwater Trends for WMA B

April 2005

FIGURE 2.12



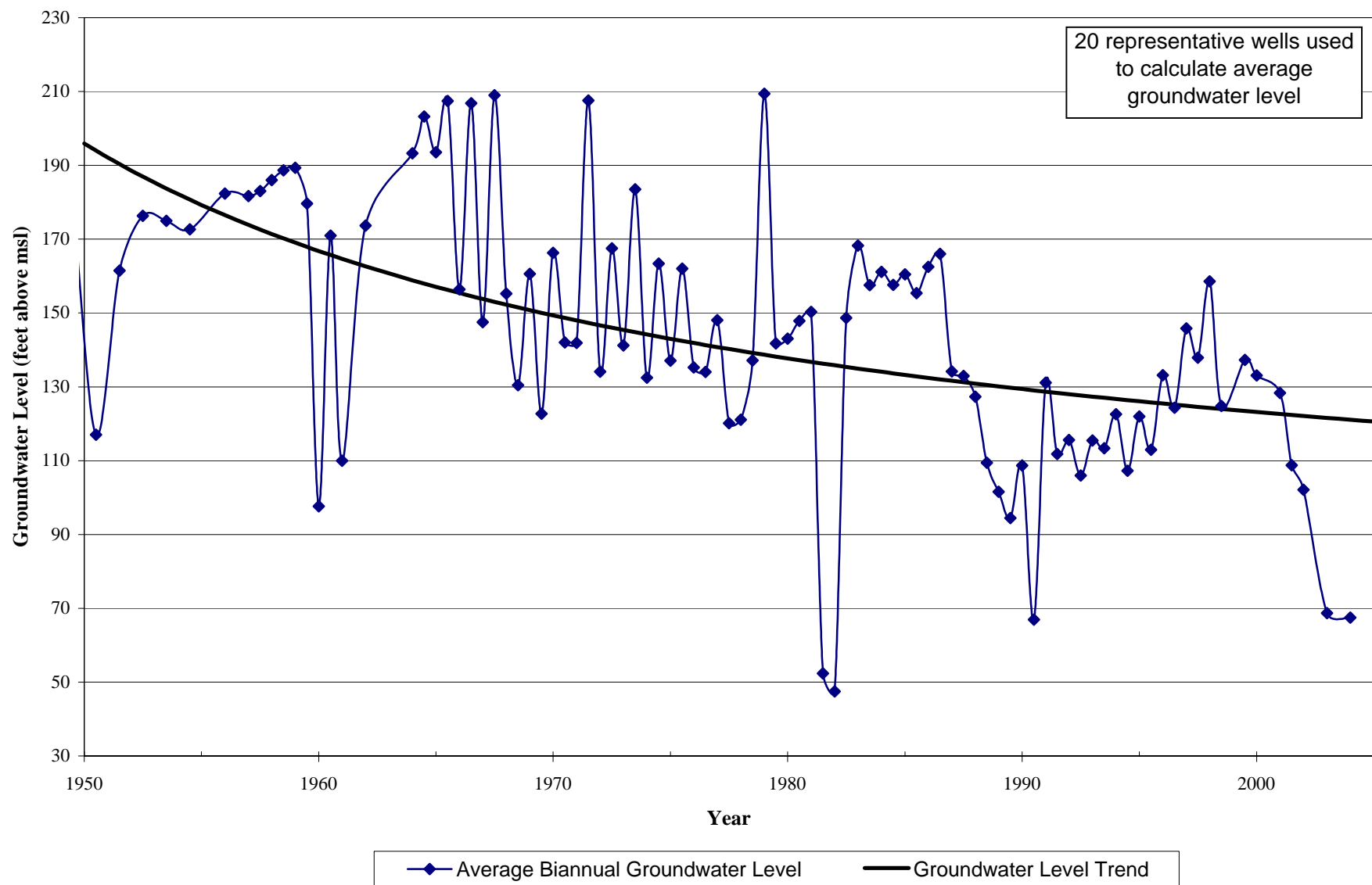


Lower Kings Basin GWMP Update

Groundwater Trends for WMA B2

April 2005

FIGURE 2.14

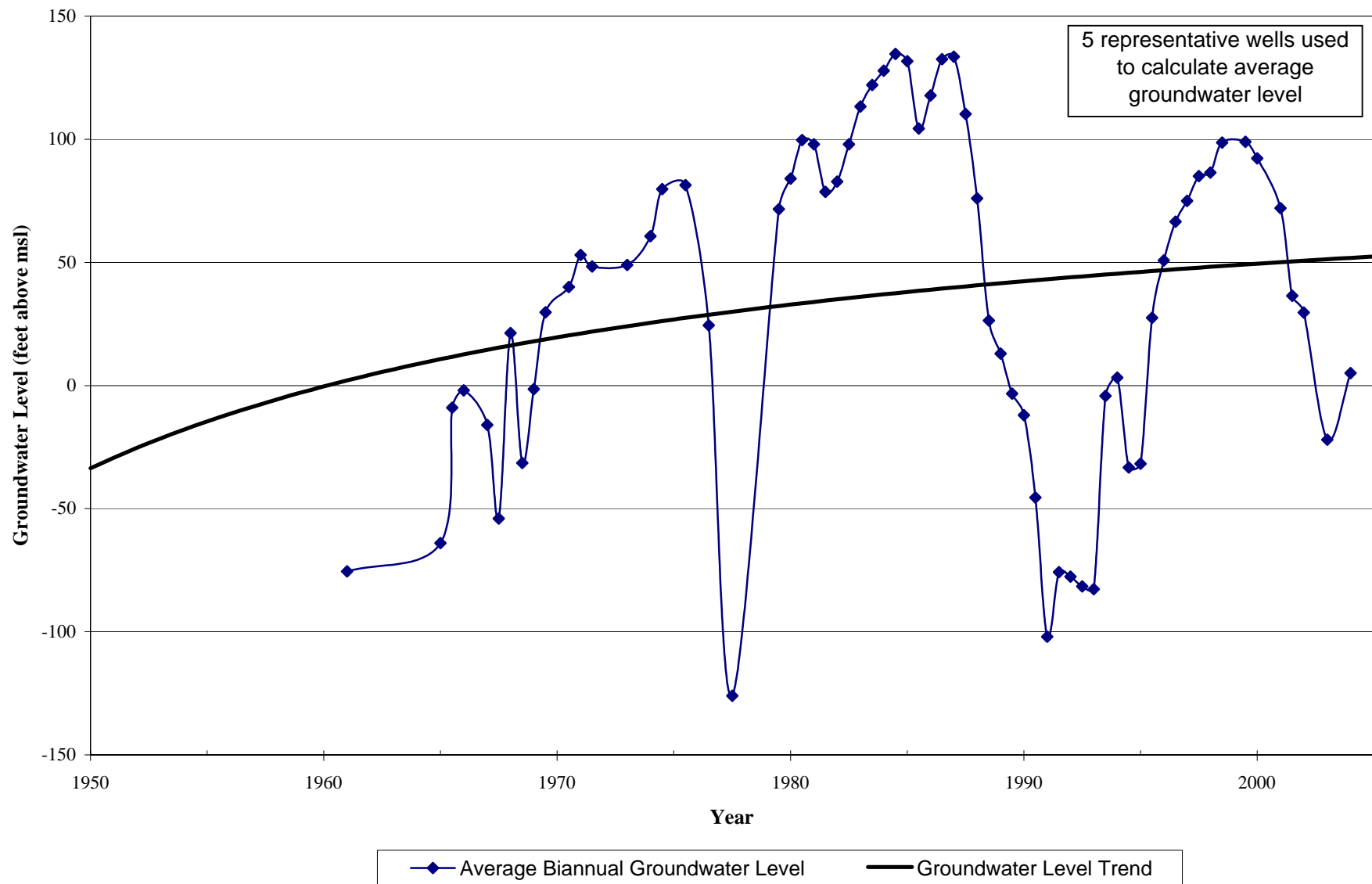


Lower Kings Basin GWMP Update

April 2005

Groundwater Trends for WMA C

FIGURE 2.15

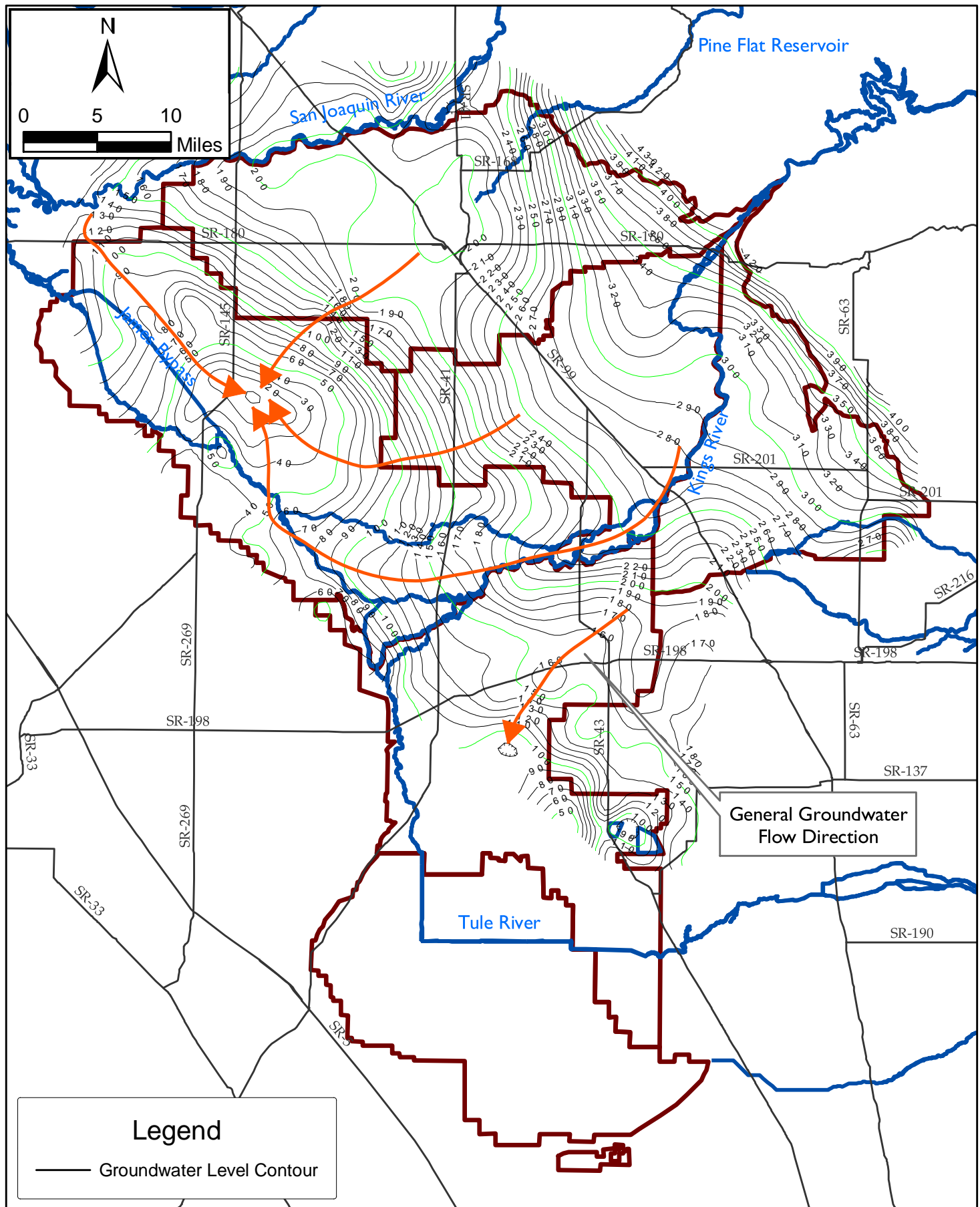


Lower Kings Basin GWMP Update

Groundwater Trends for WMA C1

April 2005

FIGURE 2.16



Lower Kings Basin GWMP Update
Spring 2000 Groundwater Levels

April 2005

Figure 2.17

msl. Groundwater moves from sources of recharge to sources of discharge and/or withdrawal. Areas of recharge generally have higher groundwater levels that decline further away from the source of recharge. The effects of recharge can be observed in the 2000 contour map. The water table elevations in the aquifer system are higher along the major rivers (San Joaquin, Kings), smaller streams, sloughs, and in unlined canal networks, where sand and gravel deposits permit water to percolate downward into groundwater storage. Water table elevations are also higher in the area to the east that underlies FID and CID.

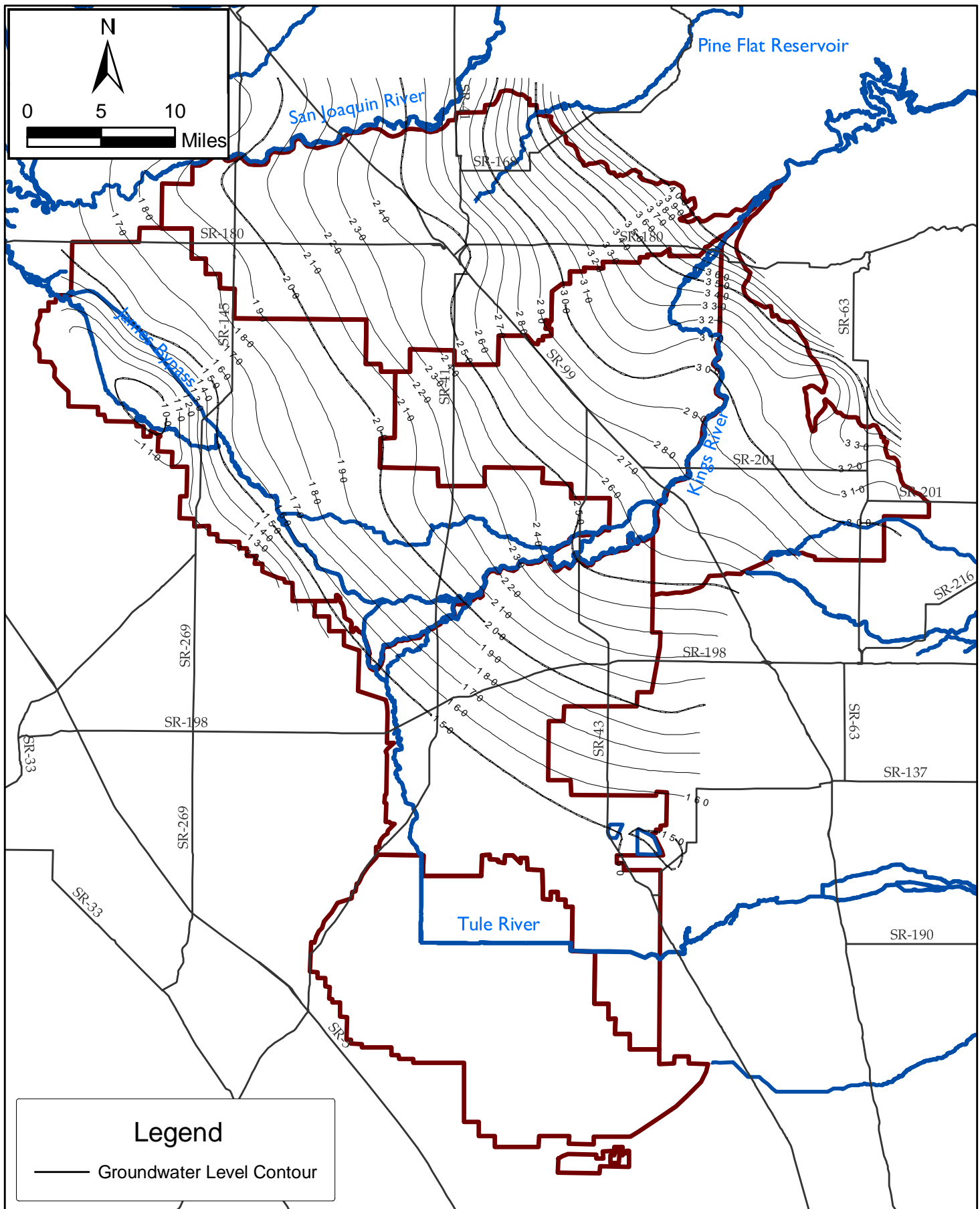
Although not illustrated in Figure 2.17, areas of groundwater discharge may occur along streams where the water table elevation is above the elevation of the stream channel. This information was obtained during the individual interviews with district staff and growers who indicated that flow has been observed in the lower reaches of the Kings River, where the river turns north, at time when upper parts of the river had already gone dry. This condition only occurred during wet years with above average recharge in the lower reaches of the Kings River. In this area, groundwater is also perched above clay layers.

Lowered water table elevations are observed in areas with a high volume of pumping and are farther away from the source of recharge. Figure 2.17 also shows the general flow path of groundwater movement toward the regional cone of depression that forms in WMA A near Raisin City. A groundwater trough, or regional water table depression, is a feature of the Lower Kings Basin in WMA A since there is a total reliance on groundwater and because the area is relatively far away from the Kings and San Joaquin River which are the major recharge sources. Based on the evaluation of contour map, groundwater in this area is primarily recharged from underflow from surrounding areas.

Another regional cone of depression exists under the City of Fresno as a result of year round municipal pumping. As shown in the water table contour maps contained in Appendix D, other years also show this general trend and flow pattern.

CHANGE IN GROUNDWATER STORAGE

Figure 2.18 shows spring 1950 groundwater levels in the Lower Kings Basin. This contour map is illustrative of the groundwater level conditions before the full development of agriculture and prior to construction of Pine Flat Dam. Figure 2.19 shows the change in groundwater levels between spring 1950 and 2000 and demonstrates that there has been a significant reduction in groundwater levels in the Lower Kings Basin. Appendix D contains additional water table maps for different time periods over the past 50 years along with other maps showing the changes between time periods.

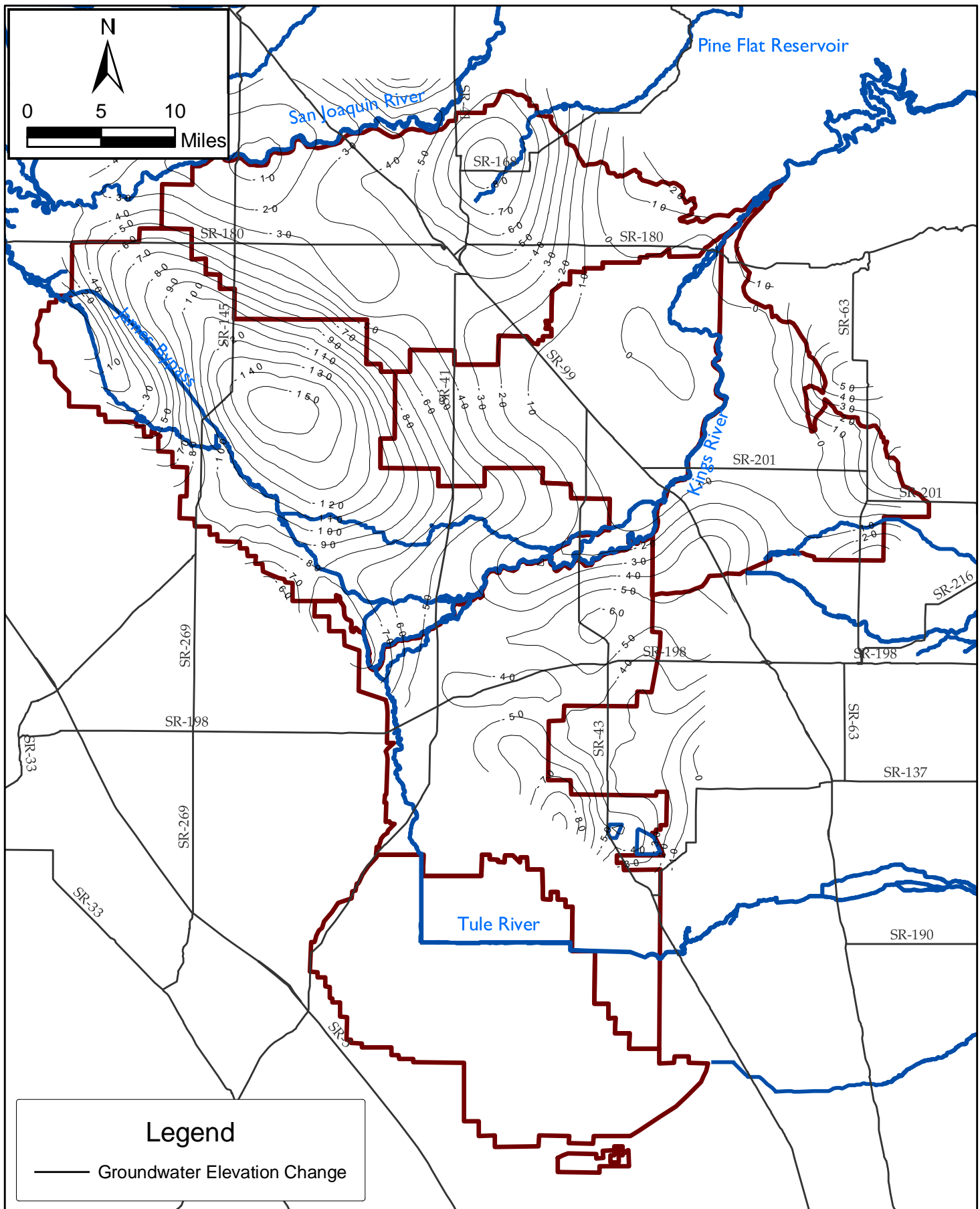


Lower Kings Basin GWMP Update

Spring 1950 Groundwater Levels

April 2005

Figure 2.18



The changes in water levels and the calculated change in groundwater storage indicate that the basin is in overdraft, a condition where more water is removed from storage than replenished on the average over time. The total volume of depletion in groundwater storage was calculated by comparing groundwater contour maps of 1950 and 2000. The analysis of groundwater overdraft is included in Appendix D. An analysis of the regional hydrographs was also conducted to evaluate the cumulative change in storage between 1950 and 2005, and between 1965 and 2005. The latter period was used to demonstrate the positive contribution from the Pine Flat Dam in reducing overdraft. Table 2.2 summarizes the overdraft analysis. WMA C1 does not appear to be in overdraft based on the hydrograph. WMA C1 was not included in the calculation.

Table 2.2. Cumulative Overdraft and Average Annual Overdraft

WMA	Area (acres)	Total Overdraft 1950 to 2005 (AF)	Annual Overdraft 1950 to 2005 (AF/yr)	Total Overdraft 1965 to 2005 (AF)	Annual Overdraft 1965 to 2005 (AF/yr)
A	112,268	1,857,000	34,000	901,000	23,000
A1	38,707	82,000	1,000	40,000	1,000
B	59,858	838,000	15,000	121,000	3,000
B1	54,099	194,000	4,000	406,000	10,000
B2	34,459	249,000	5,000	94,000	2,000
C	57,328	501,000	9,000	243,000	6,000
Total	356,719	3,721,000	68,000	1,804,000	45,000

The previous GWMPs contained water budget calculations for WMAs A, B, and C and also concluded that the area was in overdraft (KRCD, 1993; KRCD, 1995; KRCD, 1996). This study concurs with the previous analyses results and methods to the degree that such analyses can reflect the hydrologic and hydraulic complexity and operations of the Lower Kings Basin. The previous analyses did not cover all of the areas within this integrated GWMP, and data were not readily available to recreate the analyses for the expanded areas. The basin hydrogeology is complex, containing both confined and unconfined aquifers in a multilayered system. To fully evaluate the basin water budget, a model capable of evaluating the interconnected nature of the basin and complex operations should be considered to better define the overdraft, and to analyze the impacts and benefits of current or proposed management actions.

SURFACE WATER–GROUNDWATER CONNECTION

Evaluating changes in aquifer conditions requires understanding the processes and interaction taking place between surface water and groundwater as extractions and recharge in the aquifer occurs over time. Groundwater levels in the Lower Kings Basin are influenced by variations in general hydrologic conditions in the Kings River watershed. In wet periods with above average

precipitation and higher amounts of Kings River runoff, groundwater levels rise in response to a combination of decreased demand for groundwater (i.e., less pumping because of surface water deliveries and flow) and increased natural and artificial recharge. Conversely, during dry periods, groundwater levels fall because of increased groundwater pumping and decreased recharge. Specific data portraying the surface water availability and relationship to groundwater in the Lower Kings Basin are presented below.

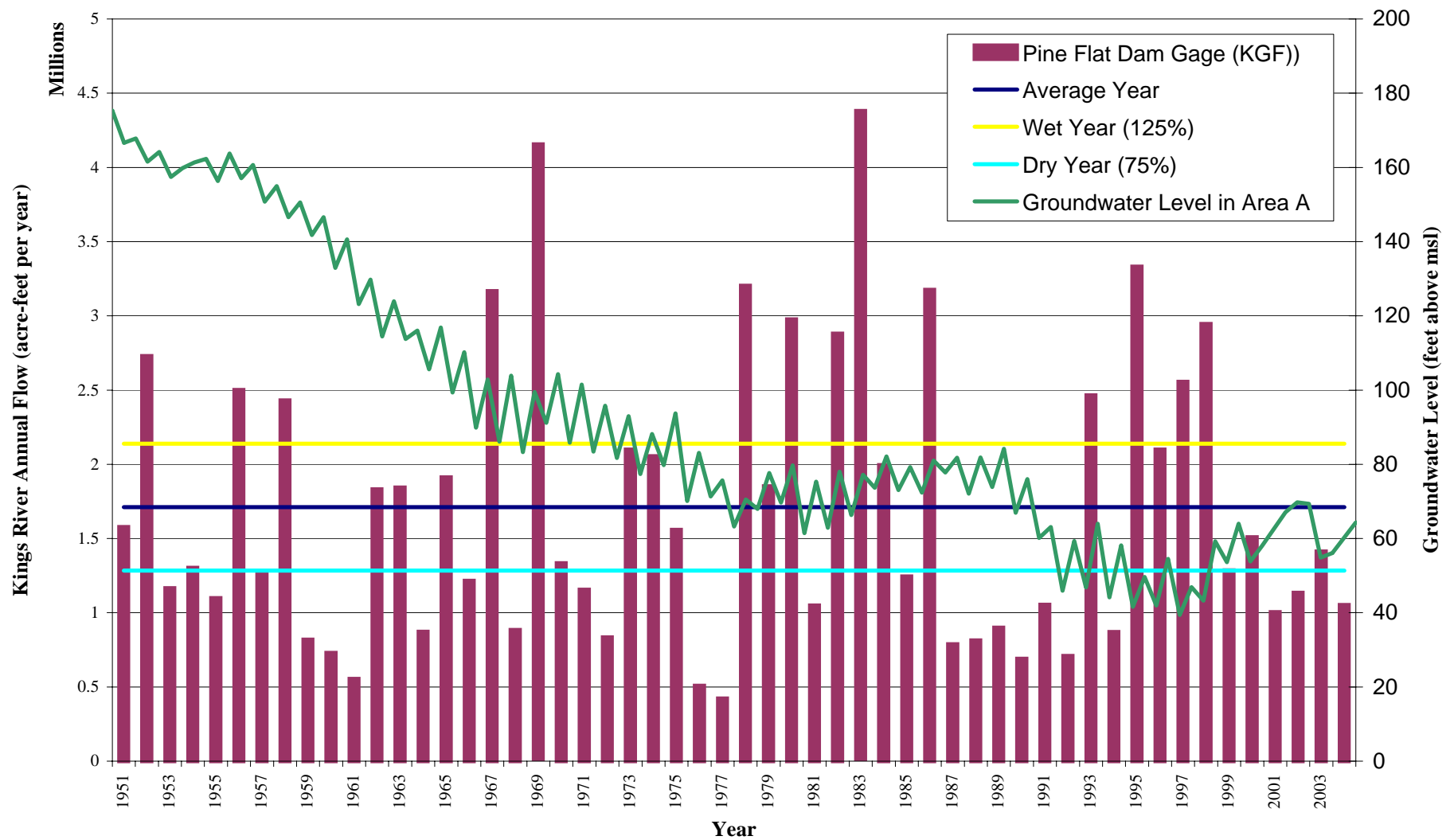
The Kings River Water Association (KRWA) uses the Kings River flows at the Piedra gage, referred to as Pre-Project Piedra (PPP), and the Blue Book of KRWA Water Policy to develop the daily delivery schedule (KWRA, 2000). The PPP is upstream of Pine Flat Reservoir and is used as the main index of hydrologic conditions in the basin. Annual PPP flows are shown on Figure 2.20 from 1951 to 2004, with corresponding average groundwater levels. A comparison of the average groundwater elevations for the Lower Kings Basin to the Kings River PPP flow shows that the groundwater elevations rise and fall with wet years and dry cycles and the high degree of sensitivity to hydrologic conditions. The figure also shows that the overall downward trend in groundwater levels through the history of both wet and dry cycles.

2.5 SURFACE WATER SUPPLIES

The basic hydrologic characteristics and systems operations of the Kings River Basin are discussed below. Also discussed is the historical surface water supply of the Lower Kings Basin. The availability of additional surface water supplies from the Kings River to support groundwater management is presented.

The Lower Kings Basin has practiced the combined use of surface water and groundwater supplies and storage, or conjunctive use, throughout the history of irrigation and water management. The area is fortunate to have developed Pine Flat Reservoir, which is very well sized for the watershed it was designed to regulate for flood control, water supply, and recreational purposes. It successfully captures, conserves, and manages the runoff from the Kings River. The reservoir has been operated very efficiently by the U.S. Army Corps of Engineers (Corps) for flood control and, in cooperation with the KRWA, for water supply purposes (KRWA, 2000).

The State Water Resources Control Board (SWRCB) has declared the Kings River to be fully appropriated (KWRA, 2000). This means there is no additional surface water that is not already committed through the complex systems of water rights and agreements that exists among the members of KRWA. KRWA is the water master for the region and supports management of the system of deliveries and Pine Flat operations on behalf of the 28 member agencies. As discussed further below, additional water diversions for conjunctive use are limited to



Lower Kings Basin GWMP Update

April 2005

Groundwater Elevations in Area A Compared to Pine Flat Outflow

FIGURE 2.20

capturing flood flows and improving conjunctive use opportunities for those entities with existing water rights and entitlements. Limitations of the amount of Kings River water available for additional conjunctive use projects in the Lower Kings Basin is in part due to historical success in managing the available surface water supply with Pine Flat Reservoir.

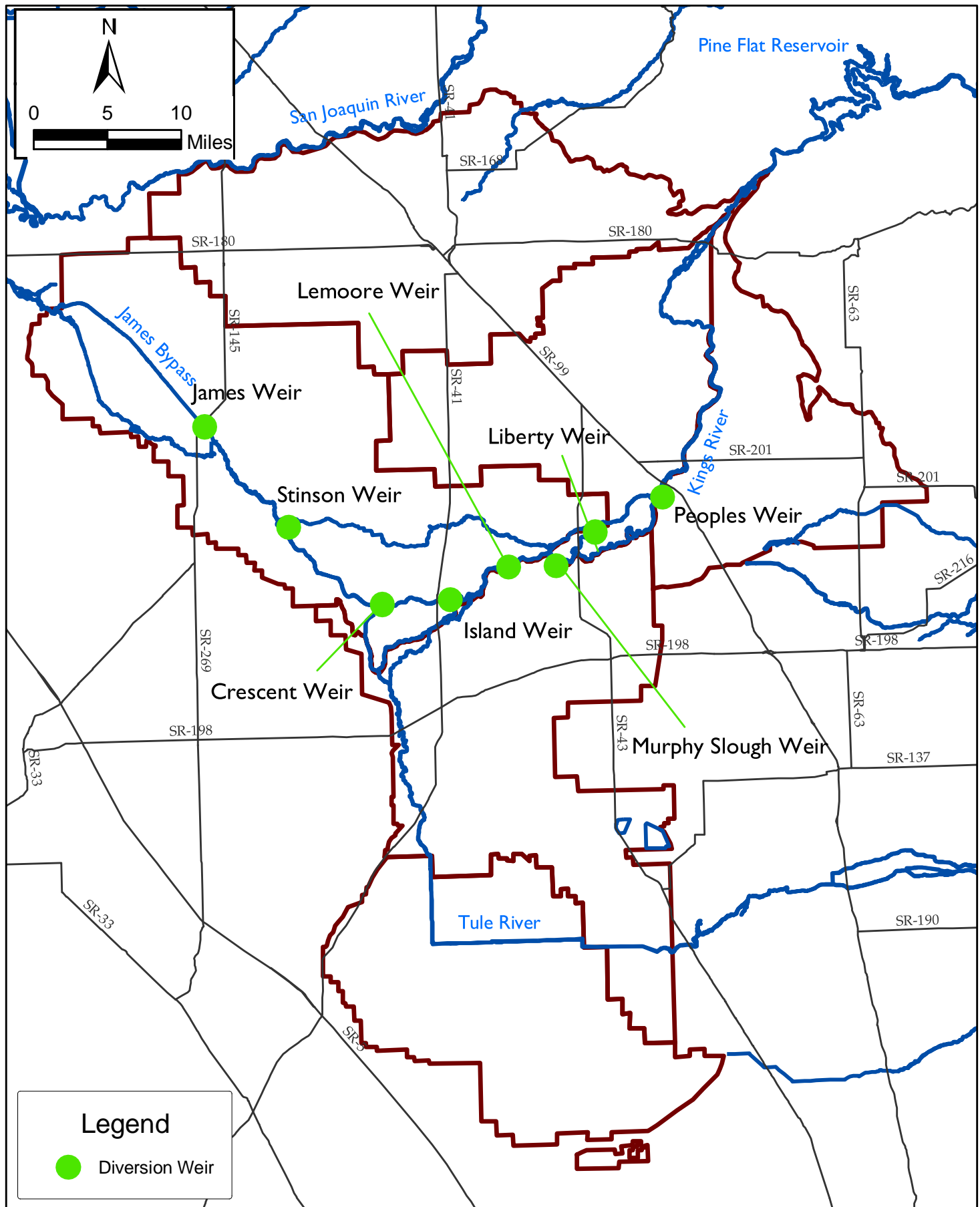
KINGS RIVER SURFACE WATER SUPPLIES

The Kings River flows westward from the Sierra Nevada into Pine Flat Reservoir. Water released from Pine Flat Reservoir to the Kings River is joined with water from Mill Creek and Hughes Creek. These creeks are unregulated and can contribute a noticeable amount of water to the Kings River. The historical flow at the PPP gage was previously provided in Figure 2.20. The average annual runoff of Kings River is about 1.7 million acre-feet (MAF) per year but is widely variable, ranging from a low of 390,000 AF in 1923–24 to a high of 4.48 MAF in 1982–83. This variability in flow is moderated to a large degree through the annual operations of Pine Flat Reservoir and by the reservoir's ability to manage carry over storage behind the dam (KRW, 2000). Kings River watershed reaches peak flows with snowmelt in May or June. The river flows westward from the Sierra Nevada and into the Lower Kings Basin, where it branches into north and south forks. The southern branch of the Kings River includes Clark's Fork and South Fork, which terminate in the Tulare Lake Bed. The North Fork flows through Fresno Slough and James Bypass to its confluence with the San Joaquin River at Mendota Pool. The Kings River discharges to Mendota Pool only during high flow periods that coincide with flood flow releases from Pine Flat Reservoir.

KINGS RIVER SUPPLY AND DELIVERY FACILITIES IN THE LOWER KINGS BASIN

Surface water supply in the Lower Kings Basin is diverted through head gates at a series of weirs (see Figure 2.21). Surface water that has historically been available to the Lower Kings Basin is best represented by the flow below Peoples Weir. Figure 2.22 shows the annual flow volume of Kings River below Peoples Weir from 1965 through 2001. Kings River flow that is measured at James Weir represents water that is lost to the Lower Kings Basin. Figure 2.23 shows the hydrograph of James Weir flow. The figure demonstrates that flow at this location is infrequent and when flows do occur, it is during flood releases from Pine Flat Reservoir. The flows at James Weir provide the opportunity for further conjunctive use projects that would capture water that would otherwise be discharged from the Lower Kings Basin and leave the planning area.

The flood flows measured at James Weir were ranked according to their daily flow rate, and a flow frequency analysis was conducted to determine the availability of water for diversion at times when flow are observed at this location. Figure 2.24 shows the frequency or percent of

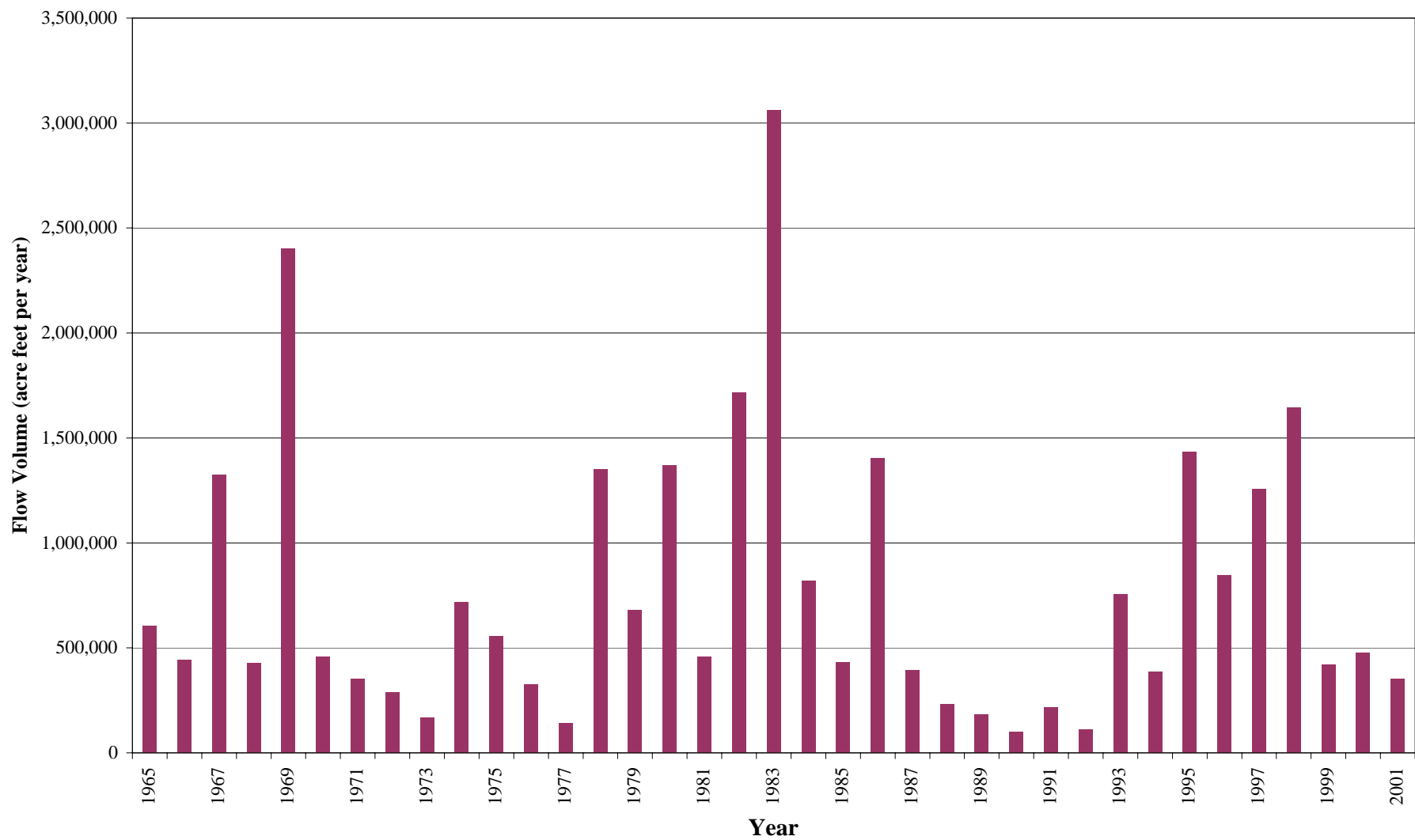


Lower Kings Basin GWMP Update

Diversion Weirs

April 2005

Figure 2.21

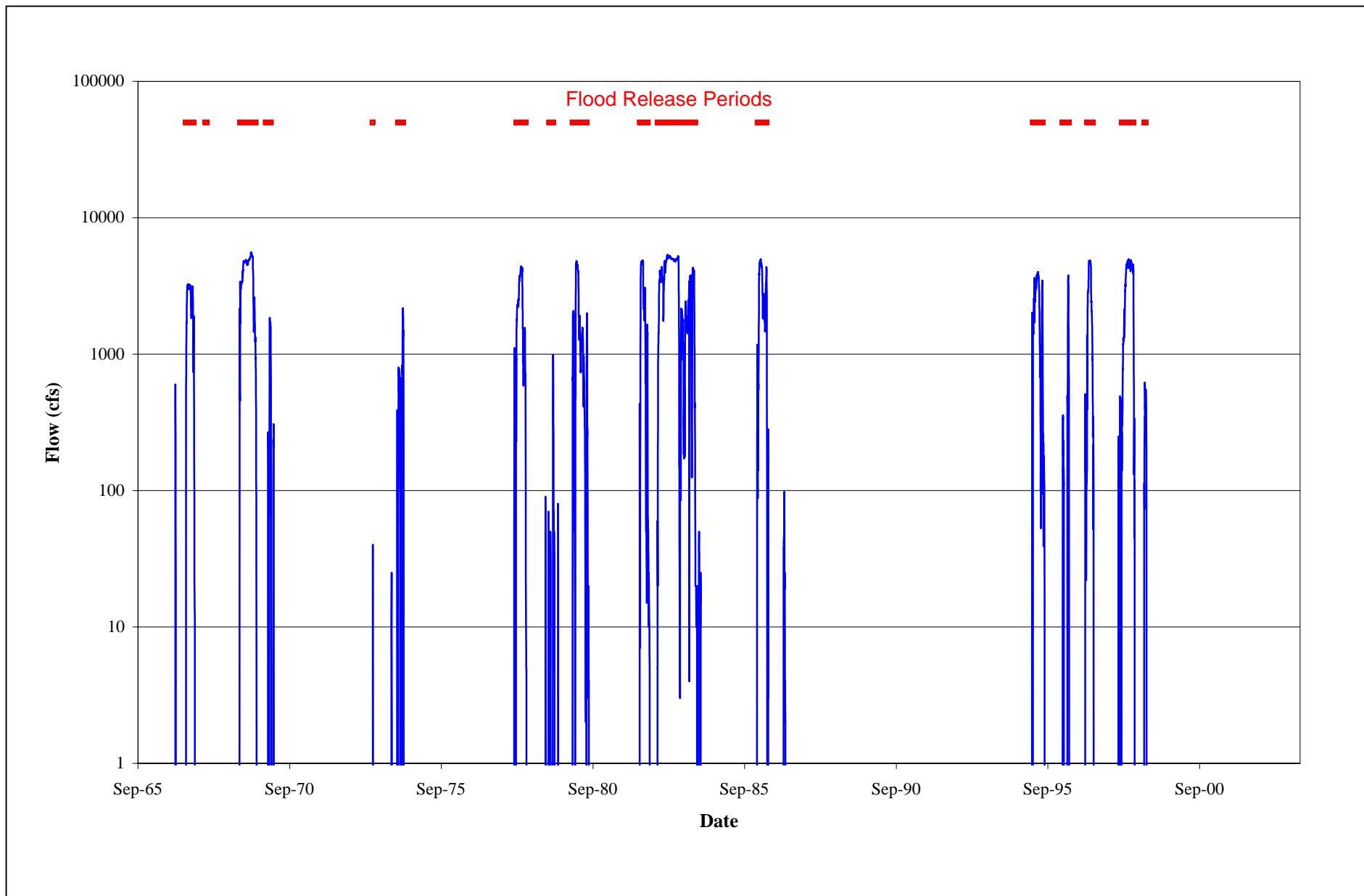


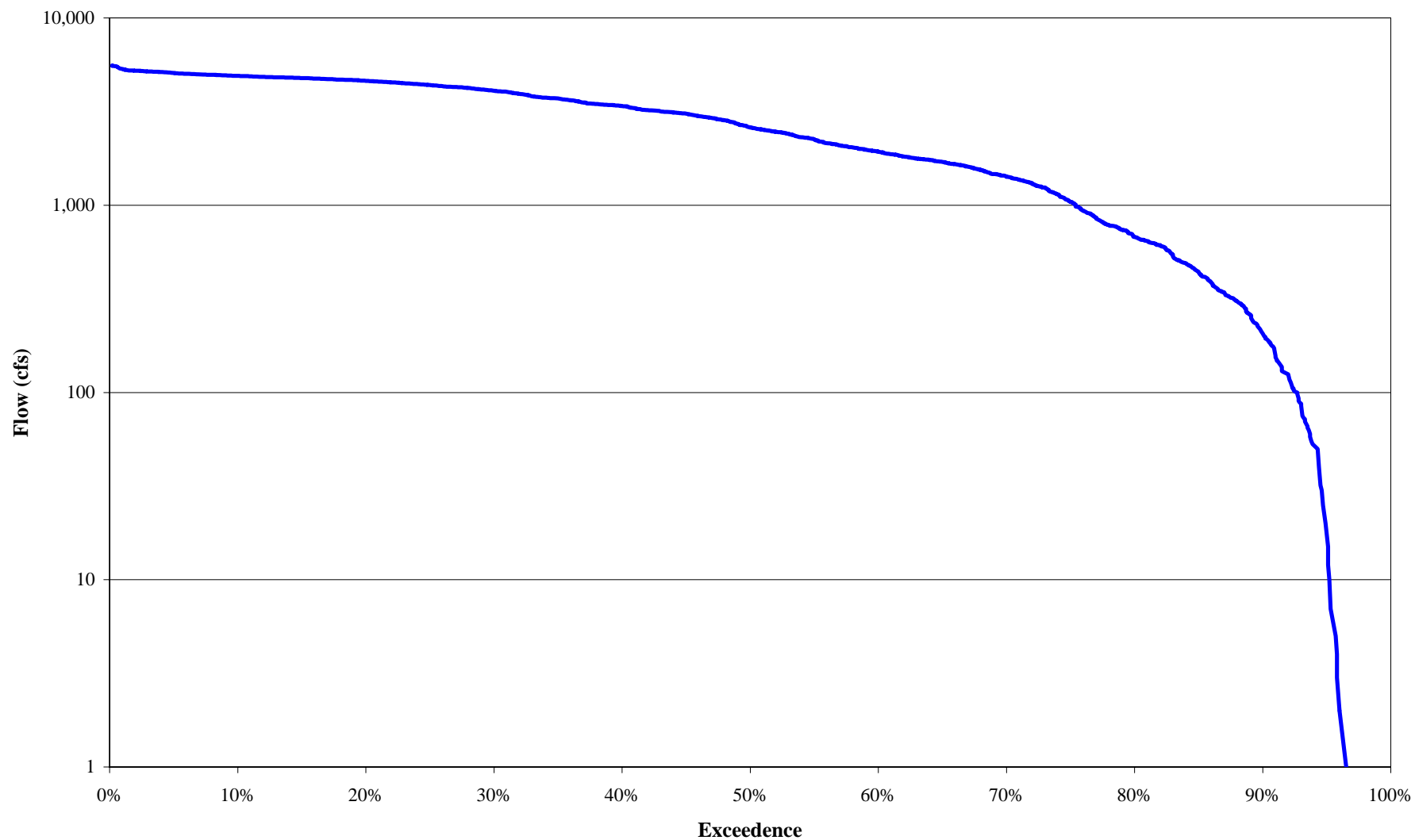
Lower Kings Basin GWMP Update

April 2005

Annual Flow Volume Below Peoples Weir

FIGURE 2.22





Lower Kings Basin GWMP Update

April 2005

Kings River Exceedence Curve Below James Weir during Flood Release Periods

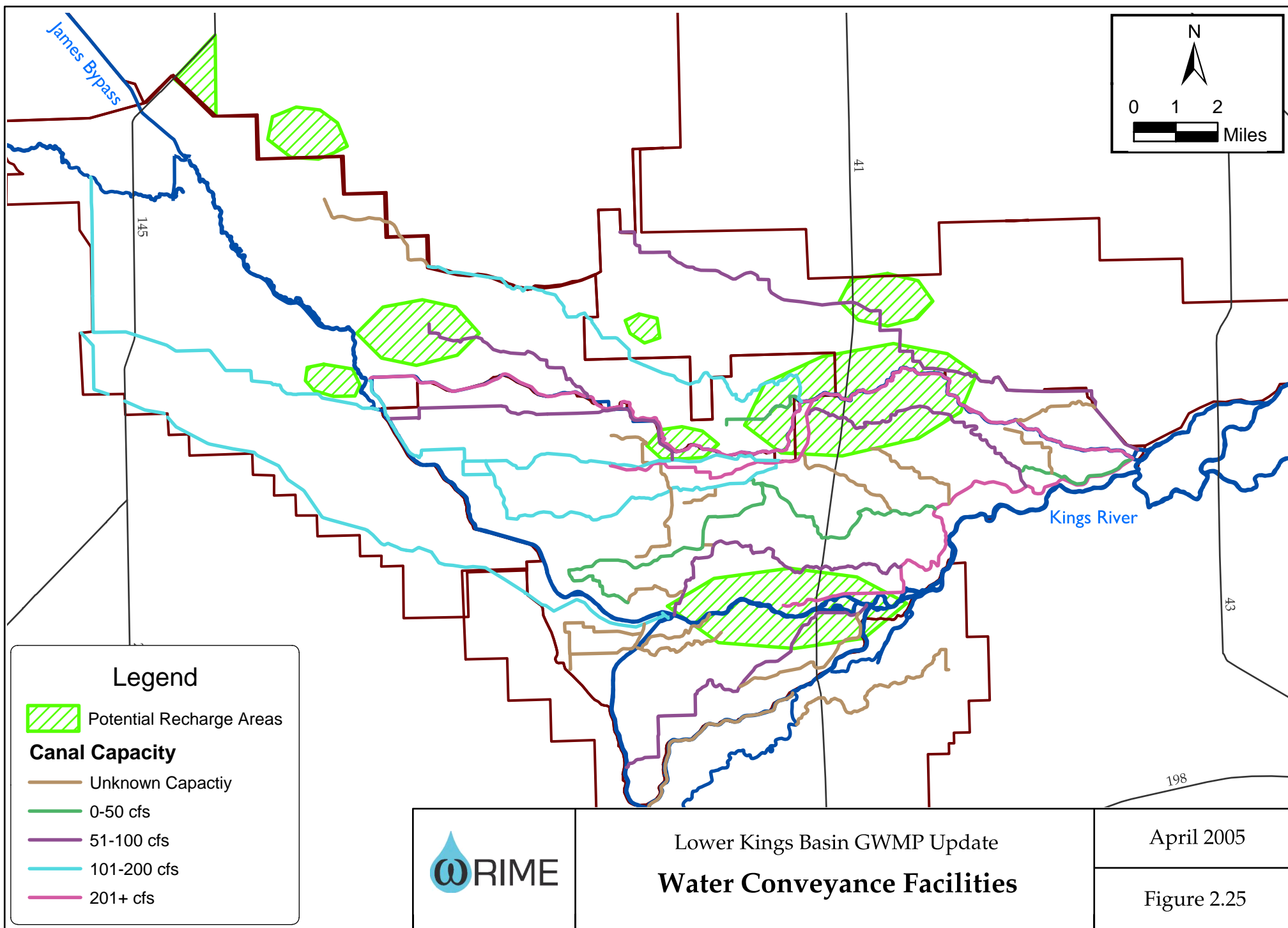
FIGURE 2.24

time that a certain flow was exceeded at James Weir. When flood flows are observed at James Weir, the flow rates are greater than or equal to 125 cubic feet per second (cfs) approximately 82% of the time, and flow rates are greater than or equal to 500 cfs approximately 72% of the time. This indicates that when flows are occurring at James Weir, there is a high probability that the flow is greater than 125 cfs. A 125 cfs flow rate has been used as a design threshold for purposes of planning and sizing facilities by KRCD (KRCD, 1999).

The previous GWMP found that groundwater recharge in a number of areas was constrained by lack of water conveyance facilities. Figure 2.25 graphically shows the relative facility constraints based on the presence of existing conveyance facilities and rights-of-way. A consolidated map of existing facilities was not available for the area. Although information resides with the water district, the ditch companies, and engineering support contractors, it is relatively inaccessible. Evaluation of constraints did not include detailed analysis of capacity, loss rates, or condition of the infrastructure.

Within WMA A, there are almost no facilities for moving surface water supplies and replace groundwater pumping. WMA A1 includes James ID and Tranquility ID and these districts have well developed water distribution systems. WMA B also has limited facilities but is less constrained than WMA A because of Stinson and Crescent Canals. There are no conveyance facilities in the western part of WMA B outside of the Stinson WD. The eastern part of WMA B includes the Murphy's Slough Association; there are a number of canals and conveyance facilities that are privately maintained and operated by overlying water districts. There are some conveyance facilities owned and operated by the local ditch companies in the western part of WMA B2, near Liberty WD, but there are no surface water delivery facilities in the eastern part of the WMA B2 (the portion of WMA B2 that as previously included in WMA A). WMA B1 is composed primarily of the NFG members with water rights and an adequately developed distribution network that is capable of taking advantage of available flood and entitlement flows.

An analysis was conducted to determine whether there was available canal capacity to divert the flood water or entitlement water during flood release (see Appendix E). The results of the analysis indicate that, for at least 70% of the months with flood releases (e.g., flow at James Weir), additional water could have been diverted through existing facilities without exceeding the canal capacities in the Lower Kings Basin. Canal capacities do not limit the ability to deliver the available water for diversion until flow rates are very high or within the 90th percentile exceedance probability.



2.6 WATER QUALITY

This section briefly reviews current surface water and groundwater quality conditions, known problems, and surface water and groundwater quality management programs. Site specific review of water quality issues and data would be conducted as part of any detailed feasibility study or environmental review of a proposed project. Monitoring is discussed in subsequent sections of the GWMP, along with the GWMP approach to further water quality protection.

The quality of the available surface water and groundwater supplies influences the ability to put the water to use. If the quality of the water is degraded beyond the ability to put the water to the intended use, overall supply is limited or the costs for additional treatment is increased. To improve groundwater management through conjunctive use, surface water of appropriate quality must be available either for direct use in lieu of a groundwater supply or for storage in the groundwater basin. State policy prevents water of poor quality to be put into the groundwater basin if the quality of the underlying groundwater would be degraded. Conversely, if clean sources of surface water are to be stored in a groundwater basin for subsequent withdrawal, the underlying groundwater quality must be such that the quality of the stored surface water would not be impaired.

There are two major types of water quality monitoring programs that produce data, ambient and regulatory. Ambient monitoring can be designed to track long-term regional water quality trends or to provide a snapshot of current conditions. This latter type of ambient monitoring is typically associated with a special study or investigation conducted for a limited duration and for a well defined purpose. Regulatory monitoring is to ensure compliance and is usually very focused on a limited number of parameters and specific circumstances. There is a wide array of regulatory programs in the basin; however, data are widely scattered and hard to collect. There are no dedicated ambient monitoring programs for the Lower Kings Basin. Available data and studies were researched and summarized for purposes of the GWMP.

SURFACE WATER QUALITY

The 1972 Clean Water Act (CWA) requires states to develop water quality control plans and meet federal requirements to protect surface water and groundwater quality. The State of California implements its requirements under the federal CWA through the Porter Cologne Water Quality Control Act. Administrative policies, procedures, and requirements for protecting waters in California are contained in water quality control plans, also known as Basin Plans. The Lower Kings Basin is covered by the Water Quality Control Plan for the Tulare

Lake Basin (Basin Plan) [Central Valley Regional Water Quality Control Board (CVRWQCB) 2004].

SWRCB develops a list of water quality limited segments, known as a 303(d) list. The 303(d) list indicates whether the water source is meeting the needs of the designated beneficial use as a result of some water quality problems. The latest available 303(d) list was prepared by SWRCB and Regional Water Quality Control Board (RWQCB) in 2002, and includes the segments of the Lower Kings River from Island Weir to the Stinson and Empire Weirs. The Kings River in this reach has elevated levels of electrical conductivity, molybdenum, and toxaphene. The 303(d) list gives the reach a low priority for the development of a total maximum daily load (TMDL).

Mendota Pool is also listed in the 303(d) list and has been defined as impaired by elevated selenium levels, potentially because of agriculture, groundwater withdrawal, or other sources. The 303(d) list gives Mendota Pool a low priority for the development of a TMDL. The Lower Kings Basin is not likely a significant contributor to the issues at Mendota Pool, but could be affected by water quality issues should Mendota Pool water be considered as a source of water for recharge.

The Basin Plan addresses the surface water quality issues of the Lower Kings River, indicated by the listing on the 303(d) list, stating that the likely sources of the contaminants are either surface or subsurface agricultural drainage, and declaring that additional on-farm management practices may be necessary as the levels of boron, molybdenum, sulfates, and chlorides become high enough to affect agricultural uses and aquatic resources. A number of best management practices have been recommended.

The Basin Plan also recommends a surface water monitoring network selected from existing DWR monitoring points. Samples will be taken to monitor for the mineral character of the stream, occurrence of toxic substances, general levels of nutrients and biological responses, and common physical characteristics. In addition, the Basin Plan calls for continued monthly monitoring by KRCD of the Lower Kings River for electrical conductivity, pH, and temperature; continued monitoring by CVRWQCB for constituents and areas of special concern; and monitoring by RWQCB of storm discharges from Naval Air Station Lemoore for hydrocarbons.

The U.S. Geological Survey (USGS) has done water quality work in the San Joaquin-Tulare Basins through the National Water Quality Assessment (NAWQA) program. The bulk of readily available data has been concentrated in the San Joaquin River and in the areas closer to the Sacramento-San Joaquin Delta, and there are few data points for the Lower Kings Basin. Other available USGS information was collected during studies to describe water quality associated with various land uses, rather than identifying local or regional water quality trends and conditions. There is some USGS information on surface water quality, including a bed sediment and tissue sampling event in 1992. Results of bed sediment sampling in 1992 showed

levels below detection limits for 16 organochlorine pesticides in the Kings River bed sediments below Pine Flat Dam and below Empire Weir 2 near Stratford. Three sites in the Lower Kings Basin were sampled for 14 organochlorine pesticides in tissue of fish below Pine Flat Dam, at Peoples Weir near Kingsburg, and below Empire Weir 2 near Stratford. Detections were made for P, P'-DDD (6 µg/kg below Empire Weir 2 near Stratford) and P, P'-DDE (16 µg/kg at Peoples Weir near Kingsburg and 95 µg/kg below Empire Weir 2 near Stratford); all other locations showed no detections. (USGS 2004)

KRWA and KRCD are participating in the Southern San Joaquin Valley Water Quality Coalition (SSJVWQC). The mission of SSJVWQC is to develop plans and implement practices that address water quality issues and concerns affecting the Tulare Lake Basin as part of the agricultural waster discharge permit waiver program. SSJVWQC participating agencies believe that they will be better served approaching these and other water quality issues on a regional basis rather than individually, and will implement monitoring plans to detect problems and management plans should problems be identified.

GROUNDWATER QUALITY

Groundwater in the San Joaquin Valley has often been divided into three zones—the east side, the central part, and the west side. Generally, groundwater on the east side is of the bicarbonate type and has low to moderate concentrations of dissolved solids. Groundwater in the central part differs greatly in chemical types and generally contains higher concentrations of dissolved solids than does groundwater on the east side, and groundwater on the west side is typically a sulfate or bicarbonate type and contains higher concentrations of dissolved solids than does groundwater on the east side (Bertoldi et al, 1991). The Lower Kings Basin lies predominantly within the central part of the valley where groundwater is a combination of water from the east side and water from the west side. Because the area is east of the central part of the valley, water from the east side predominates. The California Department of Health Services (DHS) and USGS have or continue to conduct groundwater quality monitoring programs.

California Department of Health Services

Records of drinking water purveyors and regulators are considered the best available source of information regarding groundwater quality. There are few water quality measurements available from the agricultural wells in the Lower Kings Basin. The DHS is the repository for the drinking water systems data; DHS records were reviewed for this study. It should be noted that water purveyors may relocate or deepen wells to improve water quality. This results in a break in the data and inability to evaluate trends.

DHS established the Drinking Water Source Assessment and Protection Program (DWSAPP) to provide information so that communities can develop programs to protect drinking water sources. As part of DWSAPP, source water assessments are conducted to provide information on a well's vulnerability to contamination.

A review of a number of the results for water purveyors in the Lower Kings Basin was selected to obtain a general picture of the water quality issues facing the drinking water industry in the groundwater basin. The purveyors included Caruthers Community Service District, Caruthers Raisin Packing Company, City of Kerman, City of Lemoore, City of San Joaquin, Lemoore Mobile Home Park, Lemoore Naval Air Station, Raisin City School, and Tranquility ID. Detected contaminants by one or more of these purveyors include dibromochloropropane (DBCP), hydrogen sulfide, 1, 1, 2, 2-tetrachloroethane, nitrates, and naturally occurring arsenic, fluoride, chromium, and radioactivity (DHS 2004). Potential sources of contamination include above ground storage tanks, agricultural and irrigation wells, automobile body and repair shops, automobile gas stations, dry cleaners, fertilizer/pesticide/herbicide application, home manufacturing, grazing, irrigated crops, metal plating/finishing/fabricating, septic systems, sewer collection systems, underground storage tanks, and naturally occurring arsenic, chromium, fluoride, and uranium.

United States Geological Survey

USGS has done extensive water quality work in the San Joaquin–Tulare Basins through the NAWQA program. Unfortunately, the bulk of readily available information has been concentrated in areas closer to the Sacramento–San Joaquin Delta, with little data in the Lower Kings Basin. Other available information is intended to describe water quality at various land uses, rather than identifying local water quality conditions, or is so regional in scale that only one sampling location falls within the Lower Kings Basin.

Lower Kings Basin Growers

Growers in the Lower Kings Basin monitor groundwater quality to ensure productivity. The monitoring results are used privately and are not released to the public. No data were provided to indicate that agricultural beneficial uses are significantly impaired by current surface water or groundwater quality conditions.

Groundwater management involves understanding the available groundwater resources in order to make informed decisions and meet existing and future water needs. Section 2 presented the current and historical conditions and documented the nature and extent of the problems. This section defines the goals and objectives established to address the identified problems. Once the broadest goals were established, qualitative objectives were set, and Basin Management Objectives were developed to help measure progress. The goals and objectives established by the BAP are intended to help define and priorities the GWMP actions, plans and strategies to be implemented. KRCD and Lower Kings Basin water districts worked together to develop the goals and objectives and demonstrate how local water interests can work cooperatively and speak with one voice to support groundwater banking and conjunctive use projects in the Lower Kings Basin.

3.1 GOALS AND OBJECTIVES

As presented in Section 2, overdraft of the groundwater basin is the primary problem in the Lower Kings Basin, affecting both overlying users and surrounding areas. The groundwater level hydrographs for Lower Kings Basin demonstrate overdraft conditions and the chronic depletion of groundwater storage. In general, local water demands exceed local surface water and groundwater supplies under current modes of management and with existing facilities for storage and distribution of the available surface water supply. In its most simplistic view, there is a need to either increase the supply or decrease the demand.

This GWMP is a local plan to be implemented by local interests and it clearly states goals and objectives for the Lower Kings Basin. The goals and objectives were established by the BAP early in the process to help establish and prioritize actions to solve the problems described in Section 2.

The GWMP goal is a broad statement of the intent and purpose established by the local stakeholders. During early meetings of the BAP in November and December 2004, the group identified the primary issues and concerns and the anticipated benefits that were to be realized by the GWMP. These were then used by the BAP to shape the GWMP goal and the more-specific objectives statements. The overall goal of the GWMP adopted by the BAP at the February 2005 meeting is:

To document the local approach to stopping overdraft, sustaining the local economy, and ensuring a sustainable groundwater system through development of specific projects and facilities

to capture unallocated floodwater for groundwater storage and conjunctive use, whenever and wherever such water is available consistent with existing agreements, rights, and entitlements.

The objectives were crafted to reflect the community's values and priorities for meeting the GWMP goal. The BAP expressed a strong desire to set objectives that would support developing feasible projects with reasonable costs and financial plans that provide equitable distribution of both the costs and benefits. One primary underlying planning principle is to solve problems without litigation. The proposed GWMP objectives are to:

1. Identify and build near-term groundwater recharge projects within each WMA to capture flood flows; begin to stabilize the basin; and demonstrate project feasibility, benefits, and cost effectiveness;
2. Establish rational and attainable BMOs, both regionally and for specific WMAs, to measure and track progress;
3. Formulate long-term regional strategies to take advantage of groundwater storage space in the Lower Kings Basin;
4. Maintain local control of the groundwater basin by developing agreements and institutional arrangements that promote the responsible management of groundwater resources by overlying cities, water districts, agencies, companies, and landowners;
5. Continue to coordinate the BAP to track progress, coordinate GWMP implementation;
6. Research and define financing strategies and program oversight to implement the GWMP projects and programs;
7. Implement monitoring programs that increase the understanding of Lower Kings Basin operations, track progress toward meeting goals, and evaluate and forecast conditions; and
8. Prevent degradation of groundwater quality.

3.2 BASIN MANAGEMENT OBJECTIVES

The nature and scope of the overdraft problem varies within each of the defined WMAs in the Lower Kings Basin and, depending on the Area's hydrogeology and water management infrastructure, the problem is experienced differently by the overlying users.

There is no single set of management objectives that will be successful in all areas. Groundwater management must be adapted to an Area's political, institutional, legal, and technical constraints and opportunities. Groundwater management must be tailored to each Area and WMA's conditions and needs. Even within a single basin, the management objectives may change as more is learned about managing the resource within that basin. Flexibility is the

key, but that flexibility must operate within a framework that ensures public participation, monitoring, evaluation, feedback on management alternatives, rules and regulations, and enforcement (DWR, 2003).

The State advocates the concept of local BMOs. BMO's allow for more generalized objectives that are quantitative and measurable so that progress can be tracked and monitored. The BMO concept was also developed to meet the groundwater management needs within a basin that has different groundwater users and/or overlapping jurisdictional agencies. The BMOs for the Lower Kings Basin are specific to the management and groundwater conditions found in each Area.

Coupled with dedicated monitoring and reporting of the groundwater basin conditions, the BMOs will be used by the BAP to gauge the progress in meeting the GWMP goals and objectives, and determine whether the anticipated benefits of the GWMP are being achieved. In the future, the BMOs may be used by the BAP or KRCD to "trigger" subsequent management actions or respond to changing circumstances and new knowledge.

METHOD AND APPROACH

Since overdraft is a primary problem in the Lower Kings Basin, groundwater levels provided the basis for setting BMOs.

Composite hydrographs were developed for each WMA using the available groundwater level data from representative wells within the individual WMA. Groundwater levels were projected using the data in the composite hydrograph. A planning period of 25 years to 2030 was assumed. For the purpose of projecting groundwater levels into the future, it was also assumed that groundwater operations and pumping would remain unchanged. This assumption is based on the land use and water demand analysis described in Section 2.

The composite hydrographs were used to develop groundwater level thresholds for the two primary types of BMOs established in consultation with the BAP. **Groundwater Stabilization** BMOs have been set for Areas A, B, and C using the average hydrograph and forecasted future water levels to establish target Operating Zones. Near-term projects are intended to help stabilize the groundwater levels in the Operating Zone by 2015. **Project Development** BMOs were also established by the BAP to provide preliminary engineering design targets and size potential recharge and banking project facilities. An Opportunity Zone based on groundwater levels was also identified when appropriate for the Area. The purpose of the Opportunity Zone is to define a target groundwater basin storage capacity that could be locally developed, managed, and controlled to provide long-term benefit to the overlying water users and the region.

Figures 3.1 through 3.3 present the BMOs and concepts as applied to each of the Areas. Figure 3.1 is for area WMA A. Figure 3.2 presents the aggregated hydrograph for WMA B and was used to establish BMOs for all of Area B. Figure 3.3 is for Area C and uses the hydrograph from WMA C. These figures were used to establish Groundwater Stabilization BMOs and Project Development BMOs and thresholds. Figures for the individual WMAs are included in Appendix D. Table 3.1 summarizes the measurable components of the BMOs for each Area established by the BAP at the March 2004 meeting.

Table 3.1. BMO Measurable Components

Area	Groundwater Stabilization BMOs		Project Development BMOs	
	Range of Operating Zone Levels (ft at msl)	Range of Opportunity Zone Levels (ft at msl)	Range of Diversion and Conveyance (cfs)	Range of Potential Recharge (taf/yr)
A	20 to 55	55 to 90	125 to 250	7.5 to 20
B	5 to 40	40 to 75	125 to 500	7.5 to 42
C	73 to 108	108 to 143	0 to 125	0 to 7.5

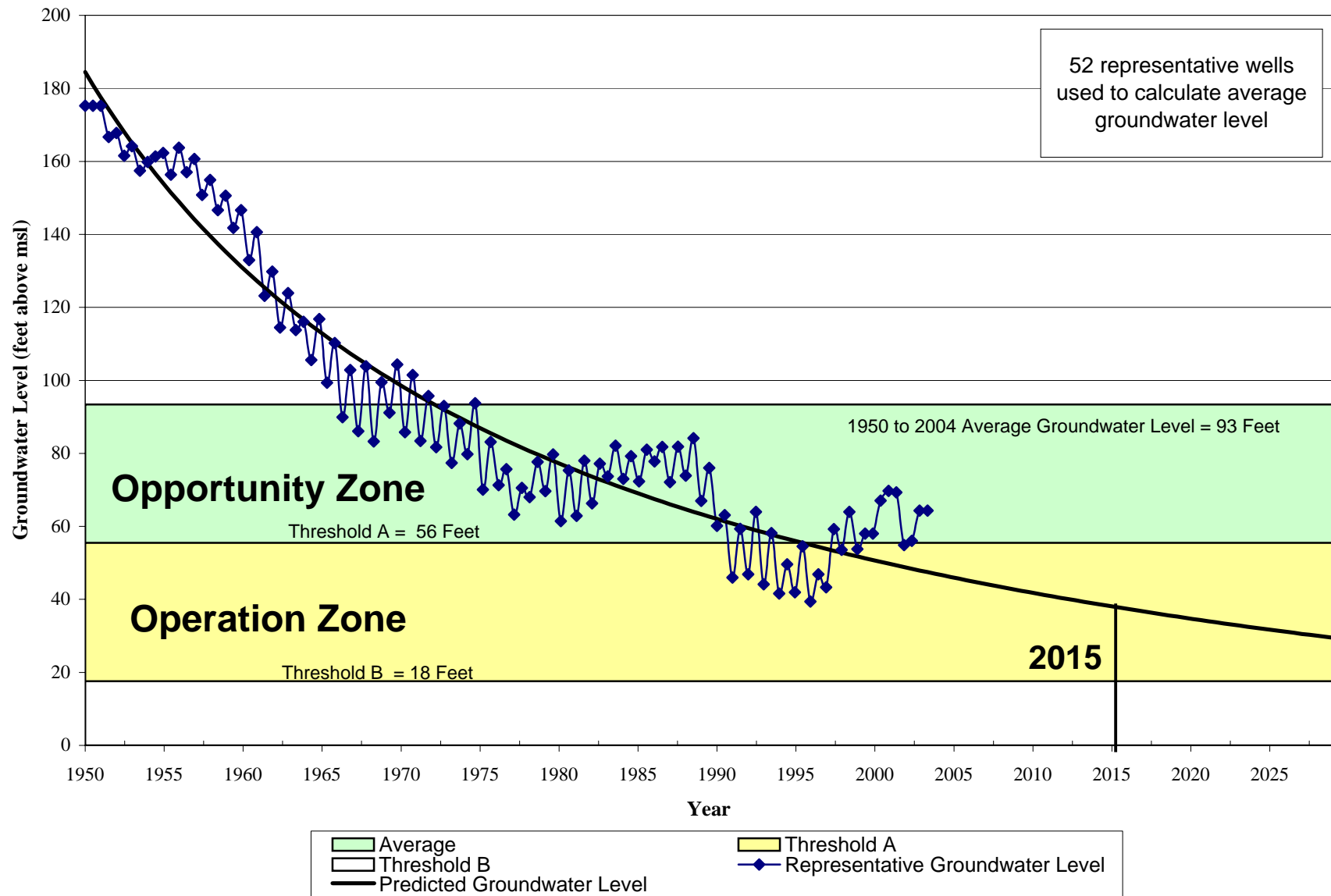
GROUNDWATER STABILIZATION BMO

Without additional projects, groundwater levels for all three Areas continue to fall past the 2015 target data for stabilizing groundwater levels in the Operating Zone. Area C is relatively stable and would appear to operate within the defined operating zone without other major actions being required. The Operating Zone sets target groundwater level ranges. Near-term, locally developed projects are proposed that will begin stabilizing groundwater levels in the Operating Zone by 2015. In other words, the 2015 forecasted level will serve as the target for the average future water level, recognizing that hydrologic variability (wet, normal, dry) would result in variations in water level within the target Operating Zone.

The Opportunity Zone is the groundwater levels range that could be achieved in the long term. It is generally recognized by the BAP that it will take larger projects and a longer time frame to overcome technical and institutional issues and develop projects that would bring water levels into this range of groundwater levels.

PROJECT DEVELOPMENT BMO

Project Development BMOs were established to provide preliminary engineering design targets for sizing recharge and banking project facilities. Since surface water availability from local

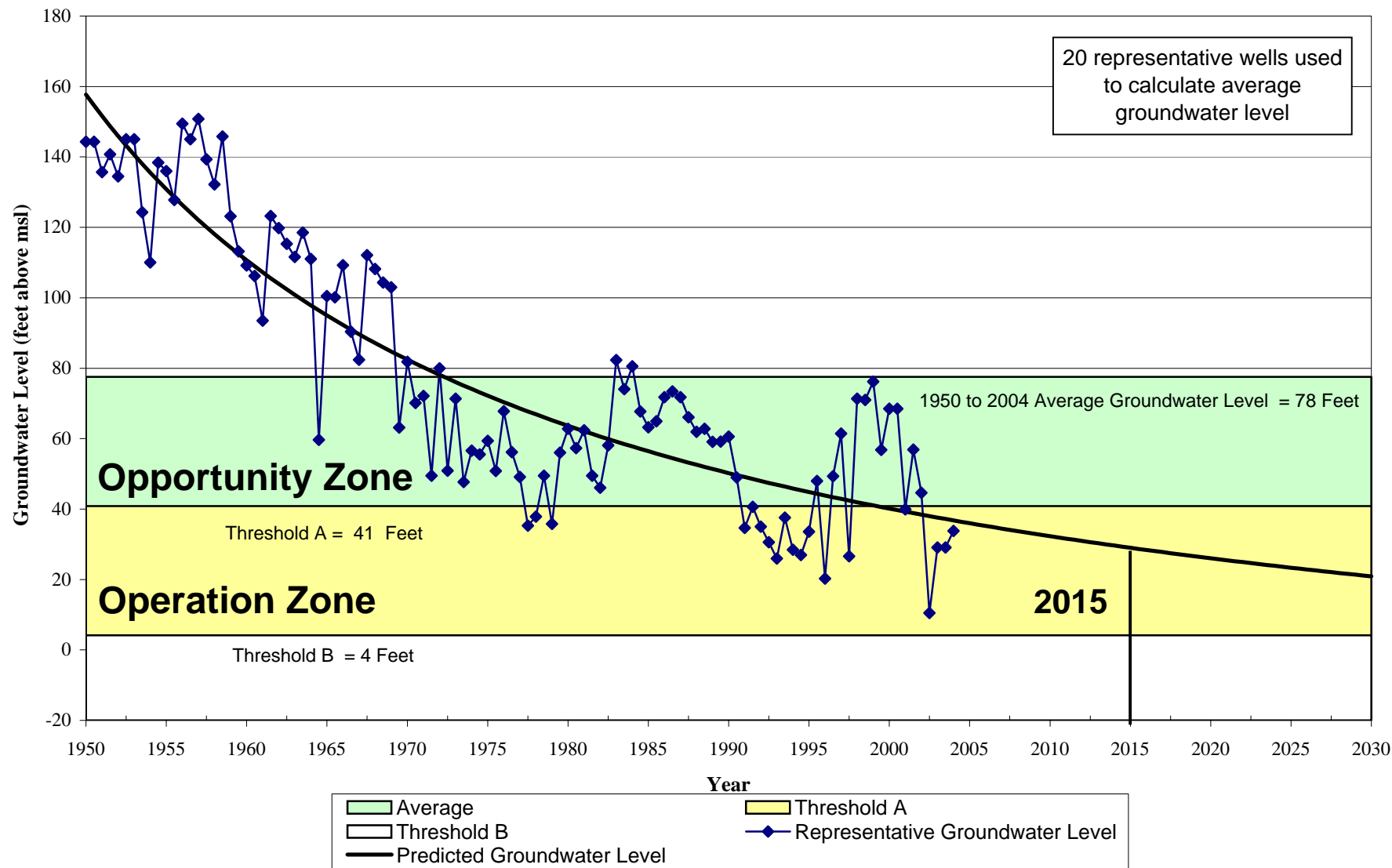


Lower Kings Basin GWMP Update

Groundwater Trends for Area A

April 2005

FIGURE 3.1

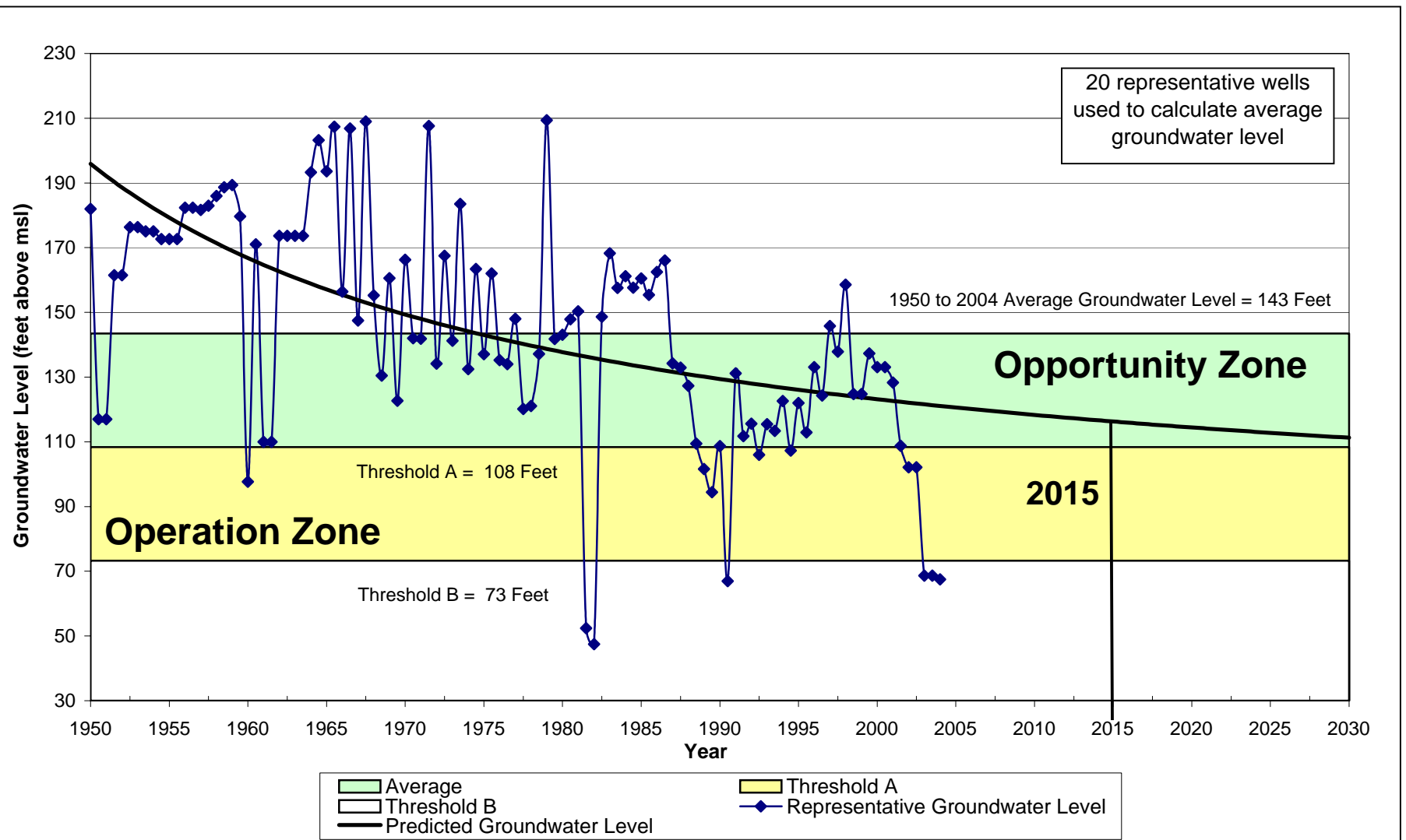


Lower Kings Basin GWMP Update

Groundwater Trends for Area B

April 2005

FIGURE 3.2



sources is a limiting design constraint, flow rates were set to provide target design capacities. The GWMP proposes both near- and the long-term actions to implement and construct capital facilities. In the near-term, these facilities would be associated with projects to supplement natural recharge in the Lower Kings Basin and stay within the Operating Zone for the Area. In the longer term, projects may be considered that include regional partners and broader participation to use the Opportunity Zones.

Near-term groundwater recharge projects in Area A would be constructed so that groundwater levels could be stabilized by 2015 and maintained within the Operational Zone. This would entail designing, financing, and building locally sponsored projects, such as those investigated and proposed by the McMullin Group and by the Raisin City WD. The BAP established a target design capacity for near term projects in Area A as between 125 and 250 cfs, and a target design recharge capacity of between 7,500 and 20,000 af/yr. The source of the water would be flood flows and other contracted water.

Near-term groundwater recharge projects in Area B are similar to those in Area A. Projects are being investigated by the North Fork Group. The design capacity of the projects is targeted to be between 125 and 500 cfs, using at least four of the seven potential recharge sites that have been identified. The source of water would be NFG entitlements and flood flow water.

Water levels in Area C are relatively stable and expected to remain within their operating zone in the future. The BMO is established in the event that circumstances change. As such, the BMO defines a management trigger.

It is expected that recovering groundwater levels to take advantage of groundwater storage space in the Opportunity Zone of Areas A and B may require regional cooperation, identification of additional sources of surface water or imported water, and a longer time frame for project development.

Longer term projects might include the development of banking and exchange programs with other Kings Basin agencies, CALFED Environmental Water Account (EWA), other water districts, and Central Valley Project and/or State Water Project contractors. These banking and exchange programs could involve storing water in the Raisin City cone of depression, where a certain volume of water would be stored in the recharge portion of the program with some of the stored water left behind for local use as part of any extraction portion of the program. The long-term, regional objective is to seek cooperation to develop regional groundwater recharge and banking programs to utilize the Opportunity Zones in Areas A and B. That program would include a comprehensive monitoring program that would allow for the evaluation of costs and benefits.

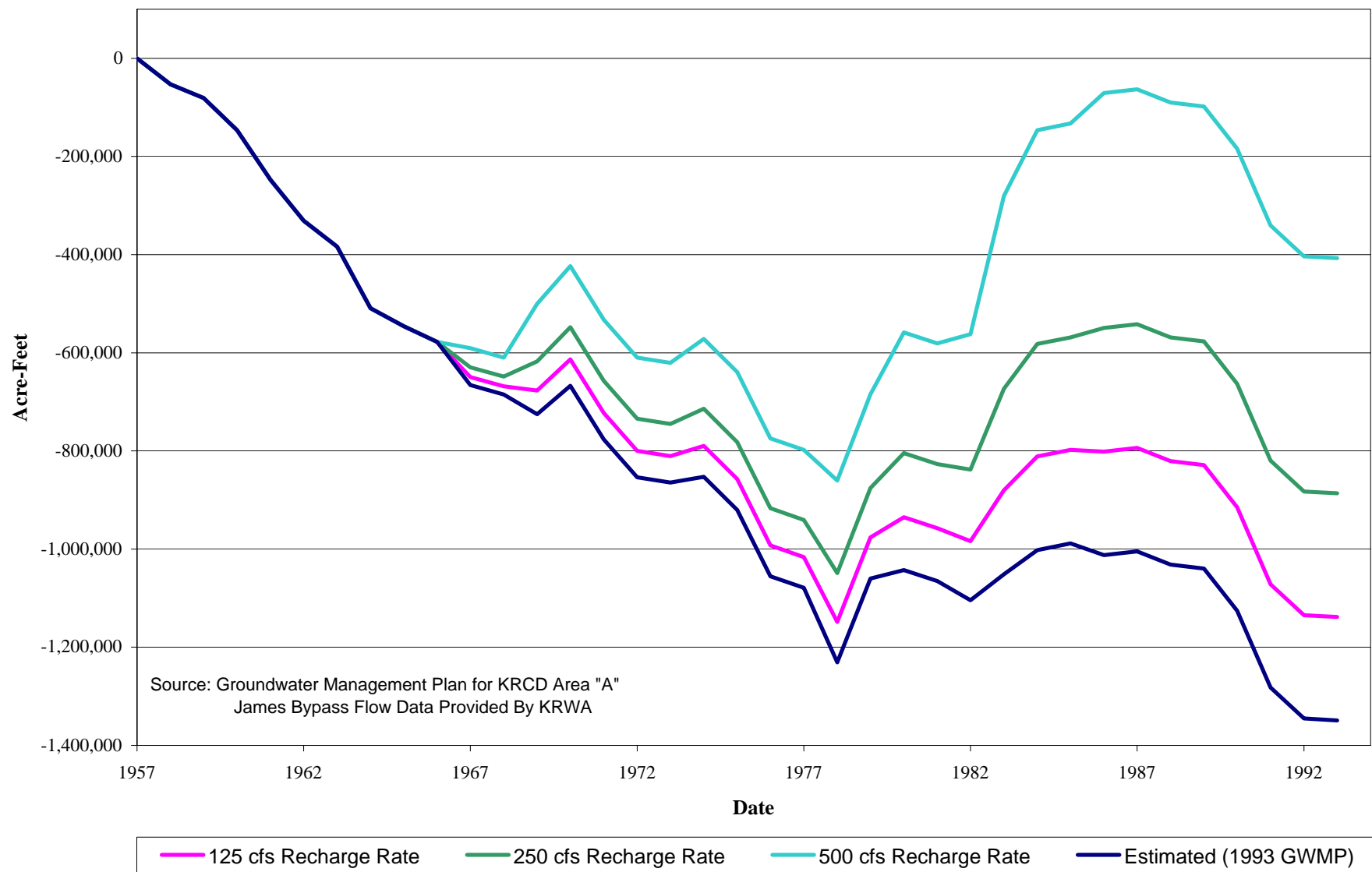
POTENTIAL BENEFITS OF MEETING THE BMOs AND PROPOSED PROJECTS

The potential benefits of the project design BMOs capacities were analyzed. The benefits of different project sizes were evaluated using the groundwater budgets from the previous GWMP, historical hydrographs, and an analysis of theoretical project yields. Potential project design capacities were assumed based on the frequency analysis of the James Weir flows and project design BMOs. To be consistent with previous reports and make use of the water budgets that were calculated, the analysis was conducted for the period from 1957 through 1993 and a baseline case for this period was developed to allow comparison of different project sizes.

The cumulative change in storage from the previous water budgets analysis was determined. Figures 3.4 and 3.5 show the results of the cumulative mass balance analysis for Areas A and B, assuming three recharge rate scenarios of 125, 250, and 500 cfs. Area C was not evaluated because the water budget did not indicate a cumulative loss of groundwater storage. The cumulative change lines show a running storage balance indicating how much water went into or was removed from storage over a specific time period. A downward trend represents depletion in storage and an upward trend indicates water going into storage.

To evaluate the potential project yields, it was assumed that the proposed project would begin operations in 1964. The amount of water available for recharge was based on the flow hydrographs at James Weir, assuming that the projects would operate only when there was at least 75 cfs. The operating rules also assumed that a recharge rate of 50 cfs would be initiated when flow reached 75 cfs, and that the recharge rate would then increase until the maximum recharge rate assumed for the scenario was achieved. To be conservative, it was also assumed that only 80% of the recharged water was stored and would be recoverable.

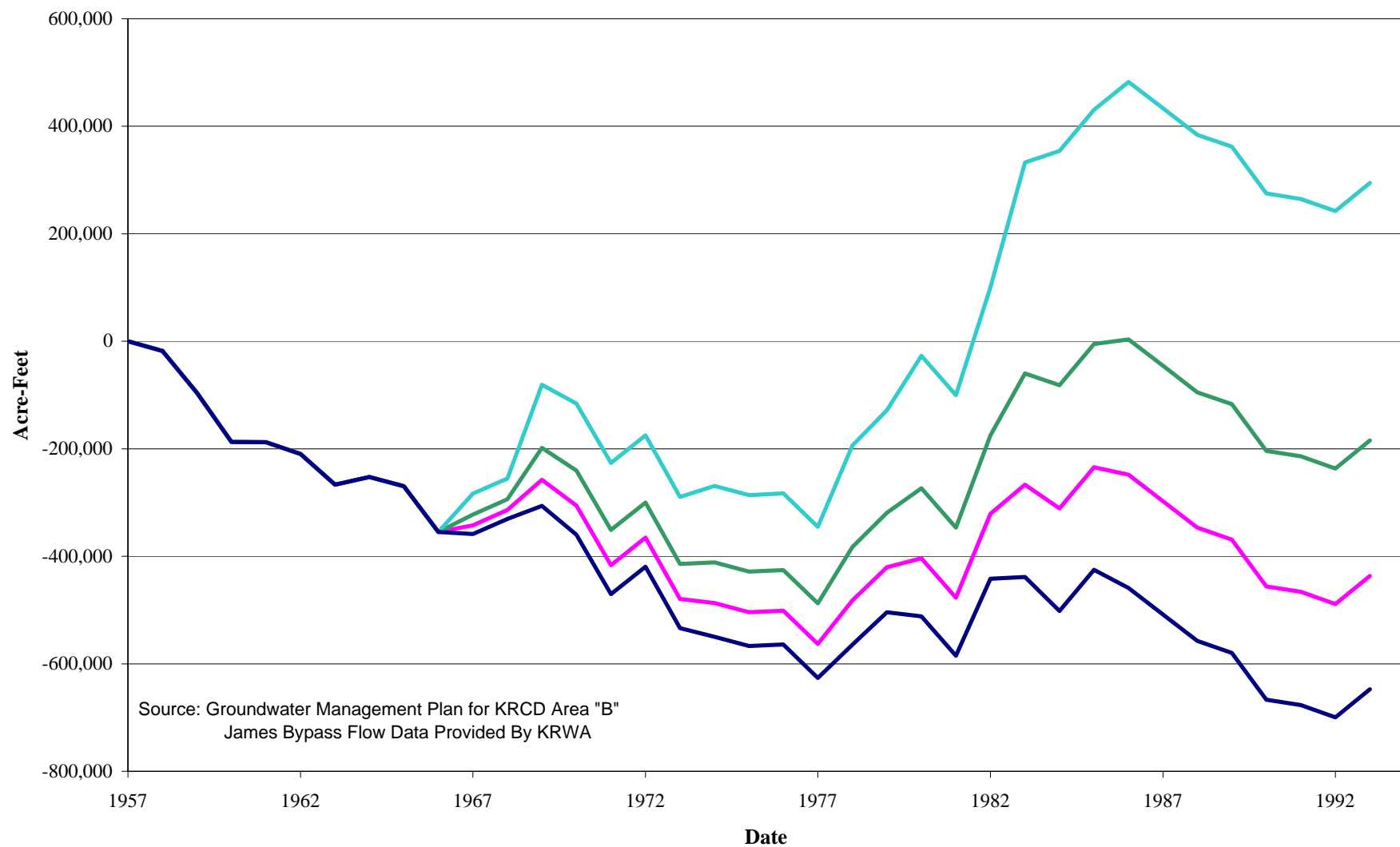
These figures show that groundwater storage steadily decreased from 1957 through 1964 under a no-project assumption, and that depletion of storage would continue through 1993. The analysis assumed that recharge projects with the indicated design capacities would have become operational in 1965. No other changes in Kings River operations were assumed. The benefits of the recharge projects are apparent. As shown in the figures, it is expected that the projects would serve to increase storage and reduce or reverse the storage depletion.



Lower Kings Basin GWMP Update
Cumulative Change in Groundwater Storage for WMA A
Cumulative Mass Balance Analysis

April 2005

FIGURE 3.4



Lower Kings Basin GWMP Update

Cumulative Change in Groundwater Storage for WMA B

Cumulative Mass Balance Analysis

April 2005

FIGURE 3.5

This section describes both the general and specific groundwater management options that were considered and discussed by the BAP. Early in the planning process, conjunctive use was recognized as the prevailing groundwater management theme. Conjunctive use is generally defined as (DWR, 2003):

The coordinated and planned management of both surface water and groundwater systems in order to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin for later and planned use by intentionally recharging the basin during years of above-average water supply.

The Kings River area provides a prime example of conjunctive use and growers have been actively managing surface water and groundwater throughout the history of the area. KRCD has been actively promoting cooperative efforts for conjunctive use and groundwater recharge within since 1989 when the Board updated a resolution directing staff to prepare GWMPs (KRCD, 1999) for WMAs A, B, and C.

This section discusses the options for further conjunctive use in the Lower Kings Basin that were considered by the BAP. It generally describes each option and then evaluates how it is related to the Lower Kings Basin. It evaluates surface water, groundwater, “other” management and water quality options, and describes issues and constraints associated with each option and Area. Based on discussions with the BAP, some of the options were not carried forward for further considerations based on the extent of the technical or policy constraints. This includes projects that would not be eligible for funding; faced serious environmental or regulatory challenges; or would take excessive amounts of time to plan and construct.

Options which were not screened were carried forward would be combined or included as a GWMP component. Surface water and groundwater management options were also characterized in terms of whether they could be implemented within the near-term or long-term planning timeframe. Near-term actions are those intended to help meet the BMOs to stabilize groundwater levels and develop projects that could be implemented by 2015. Longer term options that were carried forward are those that have greater constraints but no fatal flaws, and are expected to take more time or study, or require wider involvement to resolve the issues and implement a project.

4.1 SURFACE WATER OPTIONS

NEW KINGS RIVER SURFACE WATER STORAGE

Capturing flood flows is usually associated with new or expanded reservoir storage in off-stream or on-stream facilities. Managing flood flows with additional surface water storage would enhance conjunctive use operations and provide the best engineering solution for reducing the volume of flow out of the Kings River Basin.

A number of large-scale surface water-storage projects for the Kings River Basin have been previously evaluated, including Dinky Creek and Rogers Crossing Reservoir. Additional large-scale surface water storage could increase flood storage, provide flood control, and increase supply reliability, but these projects were eliminated from further consideration in the GWMP because they had already been set aside due to cost, regulatory compliance constraints, and limited probability of project development in a reasonable timeframe. As the California and the regional water picture change, these large-scale projects may be reevaluated in the future.

SMALL-SCALE SURFACE WATER STORAGE

Small-scale storage ponds may be constructed for purposes of regulating deliveries, retaining floodwaters, providing habitat, and improving conjunctive use opportunities. The concept is to use low-lying areas in the Lower Kings Basin along the Kings River floodway or other major conveyance to construct temporary storage in areas where recharge may be limited. This does not include ponds that are constructed specifically for purposes of recharge, but would include ponds in areas where the presence of clays or other impermeable strata would limit recharge, but would allow for short-term storage of water before spreading or percolation into other facilities more appropriately designed for recharge. Such short-term flood storage could be accomplished and provide multiple benefits related to creation of habitat, settling of sediments, detention storage, and regulatory storage to optimize water delivery infrastructures. When not fully used for water storage, the property could be used for specific types of farming operations.

Short-term storage and retention of flood flows are practiced in the Tulare Lake Basin. A local example of one type of small-scale surface storage project can be found in the northern part of Area B at Gragnani Farms. This is a showcase project developed to meet multiple objectives under the Wetlands Reserve Program (WRP) of the U.S. Department of Agriculture with support provided by NRCS. The constructed wetland is on a 6,000-acre piece of land that was converted to seasonal wetlands through purchase of conservation easements. The project was designed to provide habitat, but the facility also provides conjunctive use benefits by capturing and storing between 12,000 and 18,000 af of floodwater from Stinson or Crescent Canal. It can

be filled from or discharged to the James Bypass (Gagnani, 2005). Stored water in the wetland area can be subsequently drained and diverted for use on irrigated lands in lieu of groundwater pumping. Since there is less land to be irrigated, there is less groundwater pumping and a reduction in groundwater overdraft. Also, land that does require irrigation can use some of the stored floodwater instead of groundwater.

There are other areas where this type of project could be developed in the Lower Kings Basin; however, there are some constraints, such as acquiring land, finding willing sellers, procuring funding, and negotiating agreements for storage and project operations. Small-scale surface storage could be a design element for any regional recharge facility, or may be pursued by individual growers or water districts in the Lower Kings Basin.

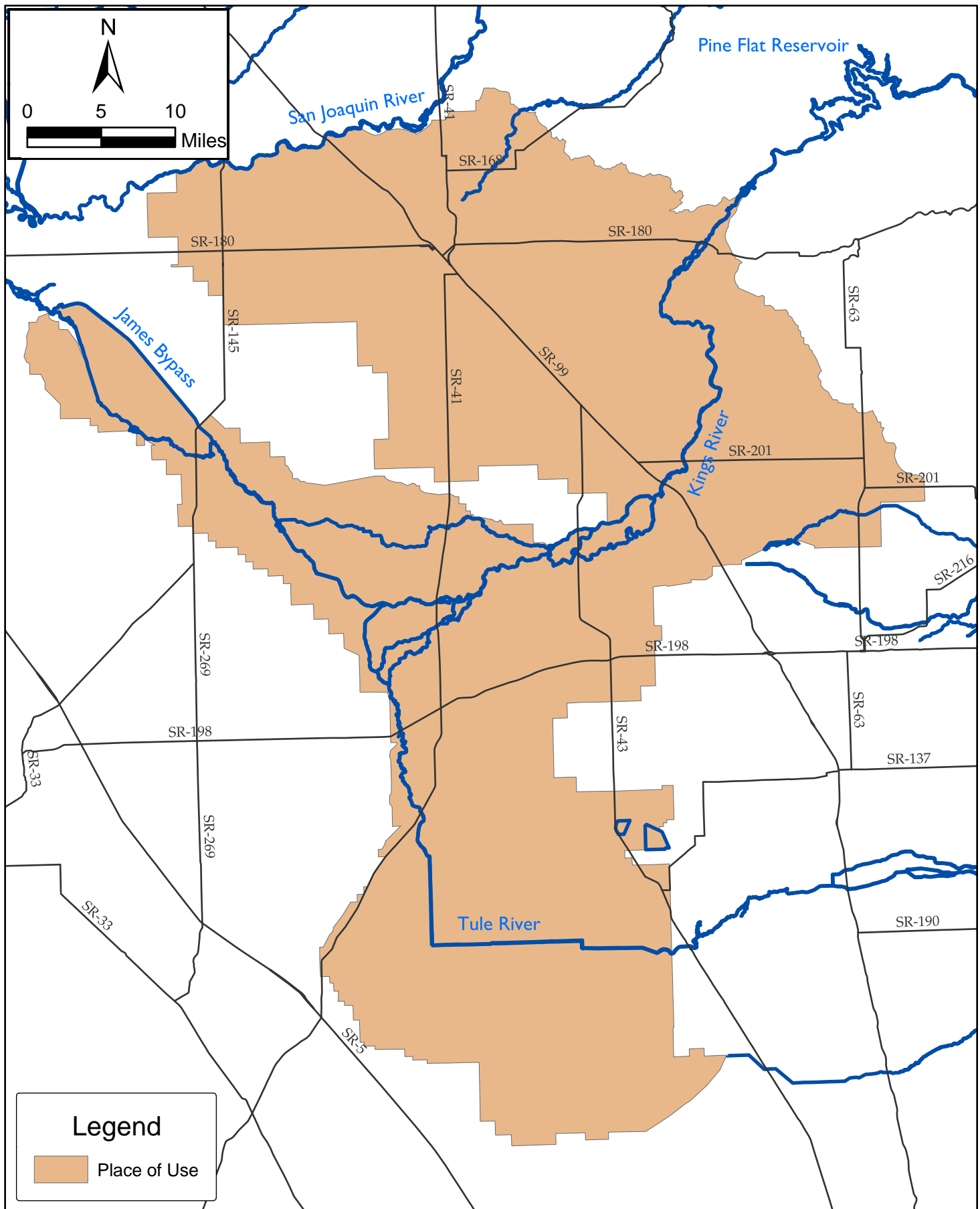
IN-BASIN SURFACE WATER AND FLOOD FLOWS

Consistent with the previous GWMPs, this analysis concluded that the amount of water available from the Kings River is expected to remain essentially the same as historical amounts, and any water available for further conjunctive use is associated with floodwater that flows past the James Bypass. The Kings River has been declared fully appropriated by SWRCB, and KRWA members have the full rights and entitlements to the available flows. Rights and entitlements, settlement agreements, and operating plans are specified in the KRWA “Blue Book”, which directs nonflood operations of Pine Flat Reservoir and the diversions from the Kings River. Included in the Blue Book is the 1992 Flood Water Agreement by which all KRWA members agreed that when flood releases from Pine Flat Reservoir exceed the total demand of all KRWA members within the Kings River Place-of-Use (POU) (Figure 4.1), permitted uses of otherwise unused water is prioritized as follows:

1. By KRWA members for use outside the Kings River POU but within Fresno, Kings, or Tulare County to facilities owned by KRWA members;
2. By KRWA members for use outside the Kings River POU but within Fresno, Kings, or Tulare County to facilities not owned by KRWA members; and
3. By anyone else with the written consent of all KRWA members.

Flood operations are coordinated by the Corps. Both the KRWA and Corps operations manual dictate how, when, and what type of floodwater would be available for recharge. Section 2 documented the flow frequency and volumes of floodwater available but did not characterize the rights or entitlements to the water. The floodwater that flows out of the planning area is either

- a. Entitlement water released as part of the flood operations but that is not diverted by the entity with an entitlement (commonly referred to as “refused water”), or



Lower Kings Basin GWMP Update

Kings River Place of Use

April 2005

Figure 4.1

- b. Uncontrolled and unallocated flood flows that are beyond any entitlement or any organization's ability to make claim to the flow.

Competition for the available floodwaters could delay project development. In addition, unless locally developed, the water leaving the area could be subject to claim by downstream interests.

Developing cost-effective engineering solutions to capture and store floodwater is challenging because of the intensity and infrequency of major storm/runoff events. None of the engineering constraints provide fatal flaws. The technical engineering constraints to develop floodwaters vary by location in the Lower Kings Basin and are associated primarily with limitations on conveyance systems to move the water to recharge areas. Institutional issues provide constraints on development of the available floodwater as a source of surface supply for recharge.

In developing recharge and banking proposals in Area A, the McMullin Group encountered issues associated with diverting floodwaters for recharge. KRCD staff drafted a number of agreements with KRWA seeking to develop a long-term agreement for floodwater to be utilized for recharge. In March 2000, the McMullin Group made a formal request to the KRWA for a 40-year agreement for a peak diversion of 125 cfs. The KRWA responded and indicated a willingness to work with the group to develop a 25-year plan. (McMullin Group Minutes 1999-2003). Ultimately, only short-term agreements and pricing arrangements were made to conduct pilot and demonstration projects, and the issues surrounding the definition of firm supply, water pricing, and contractual agreements are not resolved.

Defining the rights and entitlements to floodwaters that move past the James Bypass is needed to fully develop the floodwaters, and agreements with KRWA are needed for areas not currently in the POU or which do not currently have defined entitlements. Without some certainty regarding the availability of water for diversion and recharge, the economic investments in conveyance and recharge facilities are hard to justify, and return on investment cannot be easily demonstrated.

Hypothetically, if a portion of Kings River floodwater could be identified as not part of an entitlement, that portion of the floodwater could be moved from the Kings River POU and into Area A; however, this issue is still subject to legal interpretation and would need to be resolved as part of project development. There remain a number of regulatory hurdles associated with water rights and environmental compliance on the Kings River regarding using floodwater outside the POU. SWRCB would most likely need to approve a diversion for recharge that is not part of an existing entitlement or is a change in the POU and all KRWA members would need to agree to the change.

There are less institutional constraints in WMA B, B1, and B2 because most of these are within the KRWA boundary and the overlying water district and ditch companies have existing water rights and entitlements. These entitlements provide a source of recharge without encountering many of the issues described above. Most of Area C has access and entitlement to Kings River water and facilities to move the water.

It does not appear that there are any fatal flaws to developing in-basin floodwater and the institutional constraints do not appear to be insurmountable. However, substantive legal (e.g., SRWCB change of use hearing), political, and regulatory issues will need to be discussed and resolved before the opportunities and benefits of this option can be realized in the Lower Kings Basin.

WATER TRANSFERS

Water-transfer are becoming part of the water management landscape in California and the source of much discussion and controversy (DWR 2004, SWRCB, 2002). Water transfers are defined in the California Water Code as a temporary or long-term change in the point of diversion, place of use, or purpose of use as a result of a transfer or exchange of water or water rights¹. Transfers are a business deal among willing participants. The Lower Kings Basin could be involved in both in-basin and out-of-basin transfers. In-basin transfers would essentially imply operational changes to maximize existing conjunctive use opportunities. Out-of-basin transfers into the Lower Kings Basin would create a new source of water, and could also be linked to operation of surface water and groundwater facilities within the Lower Kings Basin.

Water transfers may increase the flexibility of the system and be linked to other water-management strategies, including surface water and groundwater storage, conjunctive management, conveyance efficiency, water-use efficiency, water-quality improvements, and planned crop shifting or crop idling. Multiple agencies could be involved and transfers and exchanges can be quite complex. Generally, water for transfer is made available for transfer by five major sources (DWR, 2000; SWRCB 2003):

- Transferring water from storage that would otherwise have been carried over to the following year. The expectation is that the reservoir will be refilled during the wet season. This would be coupled with a groundwater-banking program.
- Pumping groundwater in lieu of historically used surface water delivery and transferring the surface water rights to a third party.

¹ Temporary water transfers are defined in Section 1728 of the California Water Code as any change of point of diversion, place of use, or purpose of use involving a transfer or exchange of water or water rights for a period of one year or less. Long-term water transfers are defined in Section 1735 of the California Water Code as a transfer of water or water rights involving a change of point of diversion, place of use, or purpose of use for any period in excess of one year.

- Transferring previously banked groundwater, either by directly pumping and transferring groundwater or by pumping groundwater for local use, and transferring surface water rights.
- Reducing the existing consumptive use through crop idling or crop shifting or by water use–efficiency measures.
- Reducing return flows or seepage losses in conveyance systems that would not otherwise be recoverable for reuse.

In-basin and out-of-basin water transfers are discussed below, though no specific transfer opportunities were identified by the BAP at this time, and transfers both within and from outside the basin were only generally discussed as options. However, each of the transfer option listed above may provide an opportunity. Future transfers could be negotiated by specific individual districts within KRWA, the groups of districts and ditch companies that have formed (e.g., North Fork Group, McMullin Group), or a new Lower Kings Basin Group put together to represent common Lower Kings Basin interests and further develop transfer options as part of a longer term component of the GWMP.

In-Basin Water Transfers and Purchases

Agencies with surface water rights to Kings River could make water available to other agencies with limited water rights through willing buyer/seller agreements. To avoid any potential loss of water rights through nonuse, water districts and agencies could transfer their rights to other in-basin users for exchange and/or banking. Such water transfers or exchanges have occurred in the past among KRWA members. Water held by KRWA members can be readily moved, transferred, and exchanged within the KRWA boundary (Figure 4.1); SWRCB review is not required for such in-basin transfers. Much of Area A is not within the Kings River POU; consequently, potential transfers to Area A are subject to KRWA review, encounter a range of regulatory and political hurdles, and may require SWRCB review. Water-rights issues would need to be resolved by KRWA and SWRCB to facilitate transfers or exchange outside of the Kings River POU.

In-basin transfers have constraints and there do not appear to be any fatal flaws. As such, the option is carried forward for further review as part of both the near- and long-term GWMP.

Out-of-Basin Water Transfers or Exchange

Out-of-basin water transfers have become a key component in water-resources planning throughout the state. Water agencies and purveyors routinely import water from willing sellers to supplement their supplies. Water transfers often benefit both parties—sellers recover water-development costs because prices are often far below the cost of developing new supplies, and

seller's water rights are not affected by water transfers. This provides an incentive to promote conservation and water-use efficiency by the transferring party (Hanak, 2003). Water transfers are subject to approval by SWRCB, except in the case of transfer of pre-1914 water rights.

Out-of-basin water transfers would be a new source of surface supply. Both short-term, "spot" transfers of an existing water right, and any long-term water rights transfers would occur within an increasingly competitive market, where price is high and being driven by municipal demands.

Transfers with state or federal water contractors can be expedited, although competition is stiff and limited to those entities with facilities to deliver and wheel water between contractors. Water transfers to non-contract parties are more constrained, complex, and subject to regulatory issues. James ID and Tranquility ID are CVP exchange contractors (within Area A) and could participate in transfers within the federal project. This also could provide and opportunities to support transfers with state contractors.

Lack of existing facilities limits the ability to import or transfer state- or federal-project water into the area, but transfers or exchanges may still be possible and could provide opportunities to increase surface water sources for Lower Kings Basin. Specific new facilities, or plans to access existing facilities, would need to be identified and evaluated to transfer water from out-of-basin sources, change existing points of diversion or places of use, and provide a source of recharge the Lower Kings Basin.

KRCD is the manager for the Mid-Valley Water Authority (MVWA). A Mid-Valley Canal was previously considered to bring federal contract water into the Lower Kings Basin via Mendota Pool. The Mid-Valley Canal facilities were not constructed and this limits access to CVP water, or other water that could be transferred and wheeled through CVP facilities and enter the Lower Kings Basin planning area through the Mendota Pool. A Mid-Valley or similar facility would be needed to transfer water from sources in Northern California that would rely on CVP facilities, or from sources on the San Joaquin that would also move water through the Mendota Pool into Area A.

The Friant Kern Canal is a point of entry and potential point of departure for use in any transfer or exchange. Transfers or exchanges along the Friant Kern Canal of CVP Friant Unit water and Lower Kings Basin interests could be possible and should be considered for further evaluation as part of any long-term, regional solution that considers groundwater banking and use of Lower Kings Basin groundwater-storage space. The City of Fresno has rights and entitlements to Class I water from the CVP Friant Unit and could be part of a transfer involving Lower Kings Basin parties.

Both short-term and long-term water transfers to obtain out-of-basin water are possible and are carried forward for further consideration. Such transfers would be subject to regulatory, economic, and political hurdles and these would need to be resolved. Specific water transfer opportunities have not been identified, and are thus not considered for inclusion in any of the near-term GWMP project components. Out-of-basin water-transfer options are carried forward and should be considered and as a potential source of water and for integration into the long-term GWMP component.

OUT-OF-AREA SURFACE WATER RIGHTS OR STORAGE

Methods to acquire new surface water rights are very limited in California and are not viable because of intense competition, cost, and regulatory constraints. Water agencies and organizations within a stream system (areas of origin of a surface water) closely protect any undeveloped or unclaimed rights that might exist.

Within the San Joaquin region, SWRCB has designated most of the rivers as generally fully appropriated in summer months, when demands for water are at their peak. No water is known to be available or subject to appropriation in any of the surrounding areas. No further consideration is given to acquiring outside surface water rights.

The CALFED Bay–Delta Program includes evaluation of additional surface water storage in the upper San Joaquin River Basin. In the long term, surface water–storage projects on the San Joaquin River could be developed, which would increase the number of water supply and flood storage options in the San Joaquin region; however, these options are not practical or considered available within a realistic timeframe. Increased surface water supplies could reduce the reliance on groundwater supplies, boost additional conjunctive use opportunities, and encourage exchanges that improve supply reliability and quality; however, these benefits would primarily be targeted to existing contracts on the Friant–Kern and Madera Canals. There are no other surface water storage projects that were identified in which Kings Basin interests could participate.

Outside sources of surface water, with the exception of San Joaquin flood flows, and outside sources of surface water storage were eliminated from further consideration for inclusion in the GWMP.

OUT-OF-BASIN FLOOD FLOWS

Flood flows, or unregulated flows, are defined as either releases made from upstream storage reservoirs to maintain adequate flood storage capacity or flows in excess of in-stream flow requirements. The San Joaquin River is the only likely source of floodwater from outside the

Kings River watershed that could be readily available to the Lower Kings region. The Kings River water districts and ditch companies take San Joaquin CVP flood releases (215 water) when they it is available.

The opportunities to purchase 215 water are often not taken advantage of in the Lower Kings Basin since there are large stream losses along the Kings River that make it difficult to justify the expenditure. Such losses might also occur if water is wheeled down FID facilities or through other water districts for Area A, or through ditch-company conveyance in Area B for use in Area B, or wheeled through Area B to reach Area A. Wheeling water through Area B or FID facilities to get to Area A for recharge would require agreements. Under current state law, access to the conveyance facilities of one public agency by another public agency must be granted if there is capacity available, but the cost for wheeling water is subject to negotiations and contractual agreement. Limitations include price and lack of facilities to transfer or percolate the water when it is available. Additional 215 water could be purchased and used for recharge if there were additional facilities to deliver, spread, or percolate this water in either Area A or B. The facility constraints are discussed further below.

This is a viable source that merits further consideration in both near-term and long-term GWMP components. Water could be diverted along the Friant-Kern Canal or at the lower end of the Lower Kings Basin in the area of James ID and Tranquility ID. This latter option would require additional facilities to move water into Area A.

REOPERATION OF PINE FLAT RESERVOIR

Pine Flat Reservoir is well sized and operated for the Kings River watershed, and the historical operations have provided maximum water-supply benefits. A reoperations study was not conducted and was beyond the scope of this work; however, the reoperation of the reservoirs could include intentional drawdown of stored water below the minimum capacity required for flood-control purposes. In the context of a conjunctive use program, reservoir reoperation potentially utilizes a reservoir's carryover storage for groundwater recharge, allowing for greater flood-control capacity and a reduction in the foreseeable frequency of reservoir spills. Changes in the mode of operation would need to be carefully reviewed to avoid a detrimental effect on other reservoir benefits, such as hydropower, water supply, temperature control, and recreation. Potential impacts in these areas could limit the reservoir's ability to be reoperated to increase conjunctive use benefits.

A reoperations study should be considered to evaluate whether, in concert with additional groundwater-recharge facilities, would improve supply reliability and conjunctive use opportunities.

4.2 GROUNDWATER RECHARGE OPTIONS

The following discusses groundwater recharge options, describes existing facilities, and notes where there are ongoing feasibility studies and investigations. Issues, constraints, and opportunities are identified.

DIRECT RECHARGE TO GROUNDWATER

Surface Spreading (Field Flooding)

Surface spreading, also known as “field flooding”, has been a historical practice in the Lower Kings Basin and consists of ponding surface water on seasonally fallowed agricultural areas in late fall, winter, and early spring months for the purpose of recharging the groundwater basin. This practice has been implemented primarily in Areas B and C, using existing water rights and conveyance facilities. Increased spreading might be possible with additional distribution infrastructure and other agreements to gain access to land through easements or other incentives. Historical records to document current practices and the benefits of spreading operations in the Lower Kings Basin are not readily available, although diversion records indicate that the practice is widely applied in late winter and early spring, when water is available.

In general, this option could be used in fields having permeable soils with little or no vertical impediments. Very few minor site preparations are necessary to percolate substantial amounts of water in Areas A and B, making this method relatively economical. Recharge efficiencies can be increased by adding internal berms and check structures to create recharge cells so that water would not drain too quickly. Spreading is not effective on permanent crops such as orchards, but is feasible on vineyards, forage, and specific row crops. There could be additional environmental benefits to this approach, such as providing seasonal habitat to migratory waterfowl. Constraints include lack of surface water rights and delivery facilities in some areas, water rights POU issues, potential for loss of crops, need for “recharge” easements or other agreements, and other pricing and cost considerations.

None of these issues are fatal flaws, and the concept is carried forward as part of the near-term and long-term GWMP components for further consideration.

Recharge Basins and Ponds

Unlike field flooding, spreading basins or recharge ponds are dedicated facilities constructed solely for recharge purposes. There are a number of existing ponds in the Lower Kings Basin in

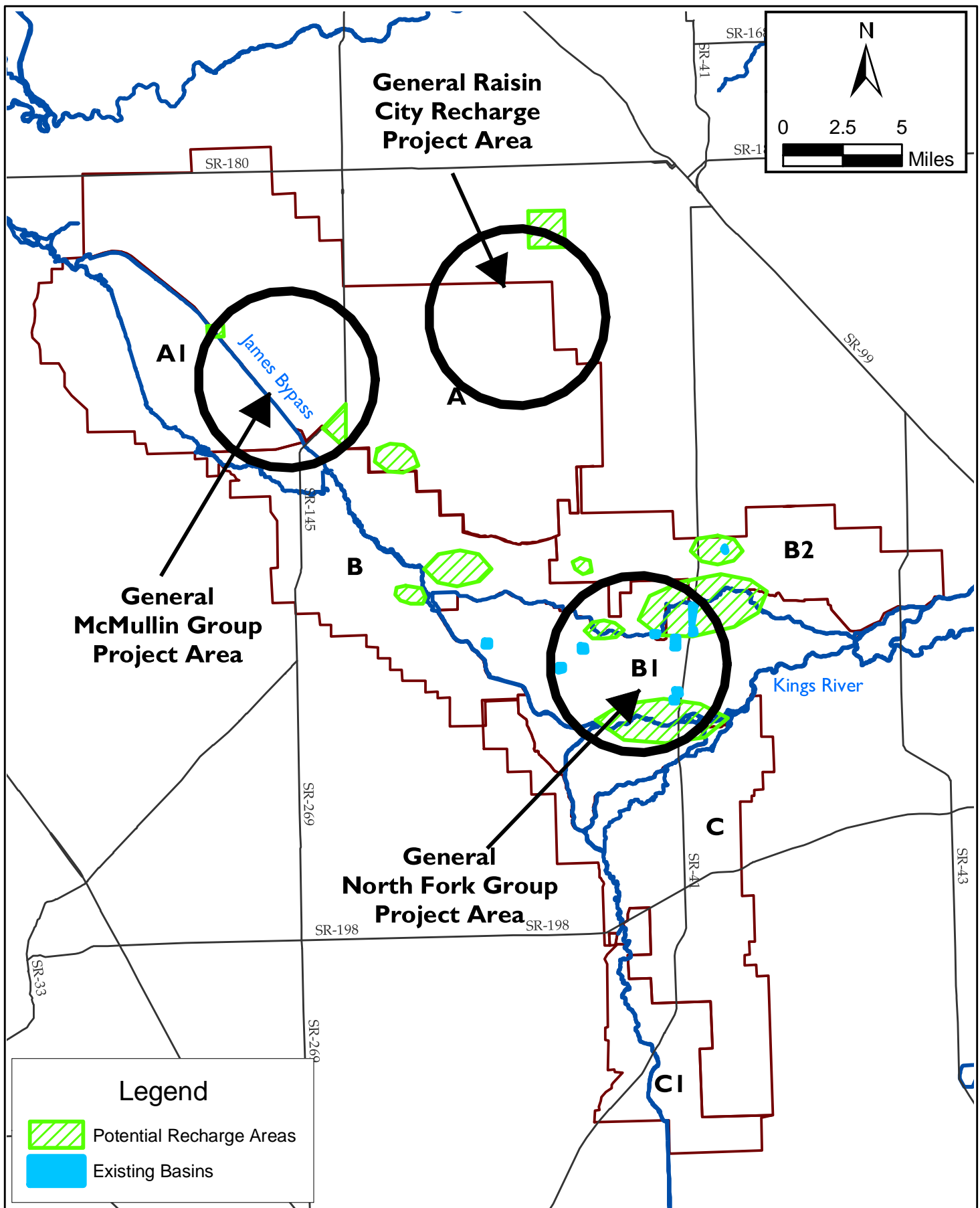
both the Laguna and Riverdale IDs, and others are proposed by The McMullin Group and Raisin City for Area A, and by the North Fork Group for Area B. No new facilities are currently proposed for Area C. Figure 4.2 shows the location of current or proposed recharge facilities. Current project concepts include the McMullin Recharge Program, Raisin City Recharge Pond, and North Fork Group Recharge Program. Each of these project concepts are considered near-term actions to meet the BMOs and are further described below. The actions to implement the proposed projects are described in more detail in Section 6 as part of the GWMP components and implementation plan.

Spreading basins are not typically rotated into production during the growing season. They consist of relatively shallow basins that are excavated to a depth of several feet. Less-permeable layers consisting of shallow, fine-grained sediment, hardpan, or clay may be excavated to provide more favorable recharge conditions in recharge ponds. Ponds may also be constructed to provide habitat value or include different habitat features, providing multiple benefits.

Recharge pits are similar to spreading basins and recharge ponds but are generally deeper and may be located in an existing natural or human-made depression, such as a gravel quarry or flood-control detention basin. Recharge pits require extensive excavation, making them well-suited for areas with a clay (aquiclude) or hardpan layer. Although not as cost effective as field flooding or spreading basins, existing quarries and flood-control detention basins could serve as seasonal recharge pits with minor site improvements and minor changes in operation. Some areas in the Lower Kings Basin may be constrained by clay layers and could make use of recharge pits; however, the application of this concept is not thought to be cost effective and is more suited to urban areas having combined flood-retention basins, such as Clovis or Fresno. Recharge ponds are viable options and are carried forward as near-term and long-term components.

Operational Examples

Laguna Irrigation District (LID) has six recharge ponds located along Highway 41 between Murphy Slough and North Fork Canal and named (from north to south): Zonneveld Pond, Dias Pond, Coelho Pond, Higdon Pond, Vaz Pond, and Everett Pond. All six ponds have good percolation; however, no official monitoring has been performed to characterize the performance of the ponds, to determine direction of flows once in the groundwater system, or to determine what effect these ponds have on increasing groundwater levels. LID also has one regulation pond along Murphy Slough about 2 miles west of Highway 41 that can function as a recharge basin, if needed. LID produced a feasibility study report in 1990 that identified seven potential recharge sites and included preliminary designs for the recharge ponds, estimates of the amount of water that could be delivered and recharged in each pond, and a cost-benefit analysis for the ponds' construction and operation.



Lower Kings Basin GWMP Update

Existing Recharge Facilities and Conceptual Layout of Potential Recharge Projects

April 2005

Figure 4.2

Riverdale Irrigation District (RID) has a limited artificial recharge program consisting of three basins that cover a combined area of approximately 40 acres. The use of the basins is sporadic because of the unpredictable supply of recharge water. When available, RID delivers Kings River flood flows and surplus CVP Friant Unit water to the basins. Two of the basins have been in existence since RID's formation in 1923 and the third was constructed in 1985. The basins are also used for systems regulation, function as storage facilities, and can be pumped out if needed. RID is looking to expand its recharge operations in cooperation with the North Fork Group.

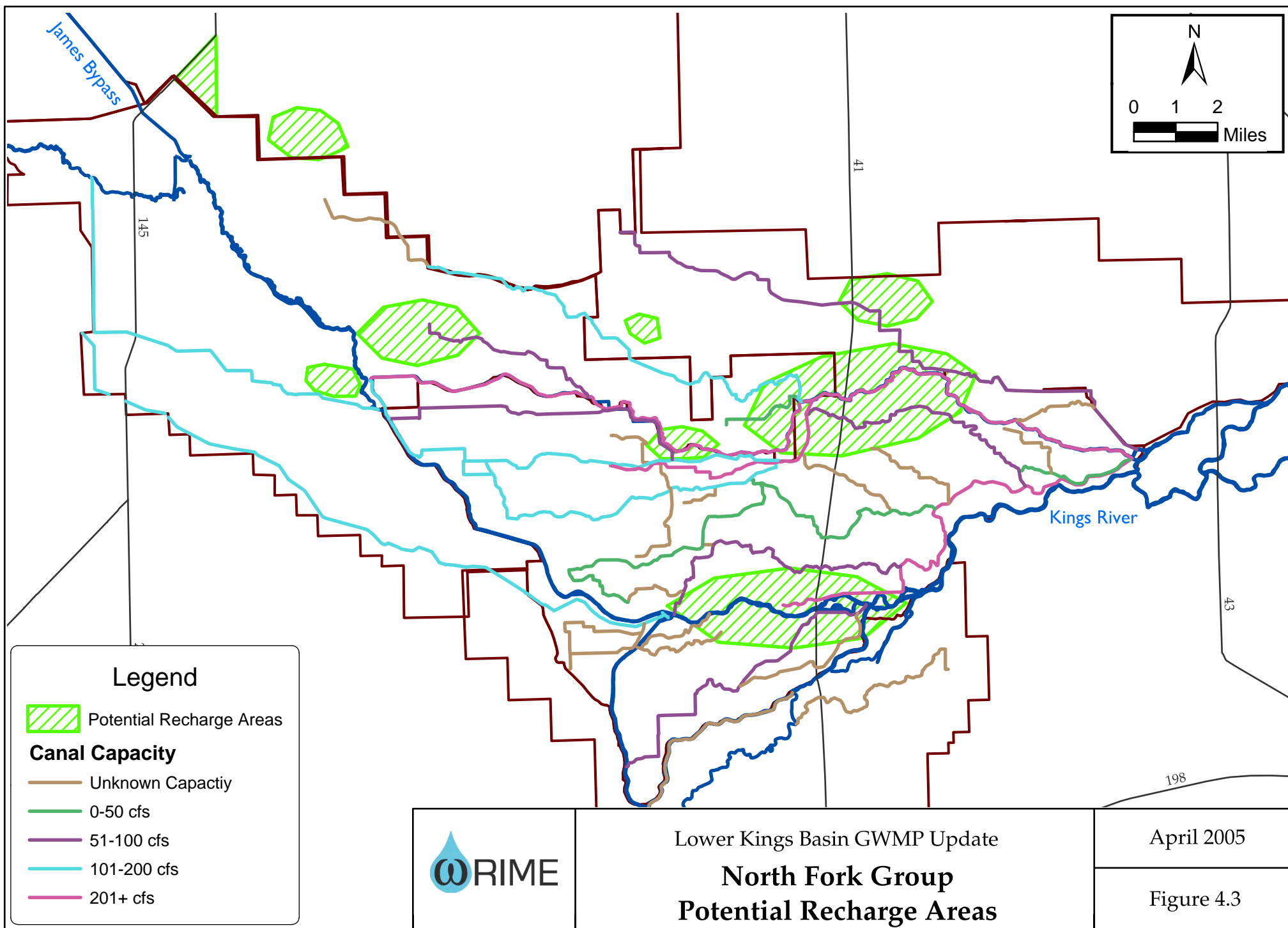
North Fork Group Program

The program elements of the North Fork Group have been identified as shown previously in Figure 2.25. The recharge areas are shown as general locations and additional feasibility and site-reconnaissance work is planned to select specific project locations and design work. The facilities would be operated by the NFG through an agreement among the members. Surface water (flood, entitlement) would be taken when it is available and would keep the ditch systems full to maximize the percolation of water to the groundwater basin. In addition, growers along the canals take water for spreading and pre-irrigation to enhance deep percolation and storage in the groundwater basin. Spreading easements and agreements with individual owners may be needed to expand the program. These practices have been standard operating procedures for years, although there has been no detailed accounting of the water recharged and the benefits provided.

There are seven potential recharge areas that have been identified by the NFG for further evaluation and feasibility studies and site review (Figure 4.3). State and local funding sources are available for these types of projects. The NFG projects are carried forward for incorporation into a GWMP component.

McMullin Recharge Ponds

The proposed McMullin Group recharge project would use flood flows to recharge the groundwater system. The project, which includes a series of ponds and canals, was investigated and a draft feasibility study was completed in April 2000 (KRCD, 2000). At that time, two sites in the McMullin Recharge Project area were considered. Site 1 consists of two phases. Phase 1, a 75-acre parcel of land that will provide approximately 67 acres of recharge area, is located on the southeast side of McMullin Road, approximately 1 mile northeast of the Kings River. Phase II consists of two 80-acre basins approximately ¼ mile east of the Phase 1 site. These additional basins provide approximately 138 acres of recharge area. A turnout structure on



James Bypass, a road crossing, approximately 300 feet of pipeline, 4,300 feet of canal, and a pumping plant will be constructed to convey water from James Bypass to the recharge basins. Site 2 includes a channel and regulation basin to be constructed within the James Bypass. The canal will be constructed along the east side of the channel and from Manning Avenue to Adams Avenue, a distance of approximately 14,500 feet, terminating in a regulating basin constructed on 20 acres of land. The basin will include a check structure and an overflow structure. In addition to serving as direct recharge facilities, both sites have the capability to deliver in-lieu recharge water.

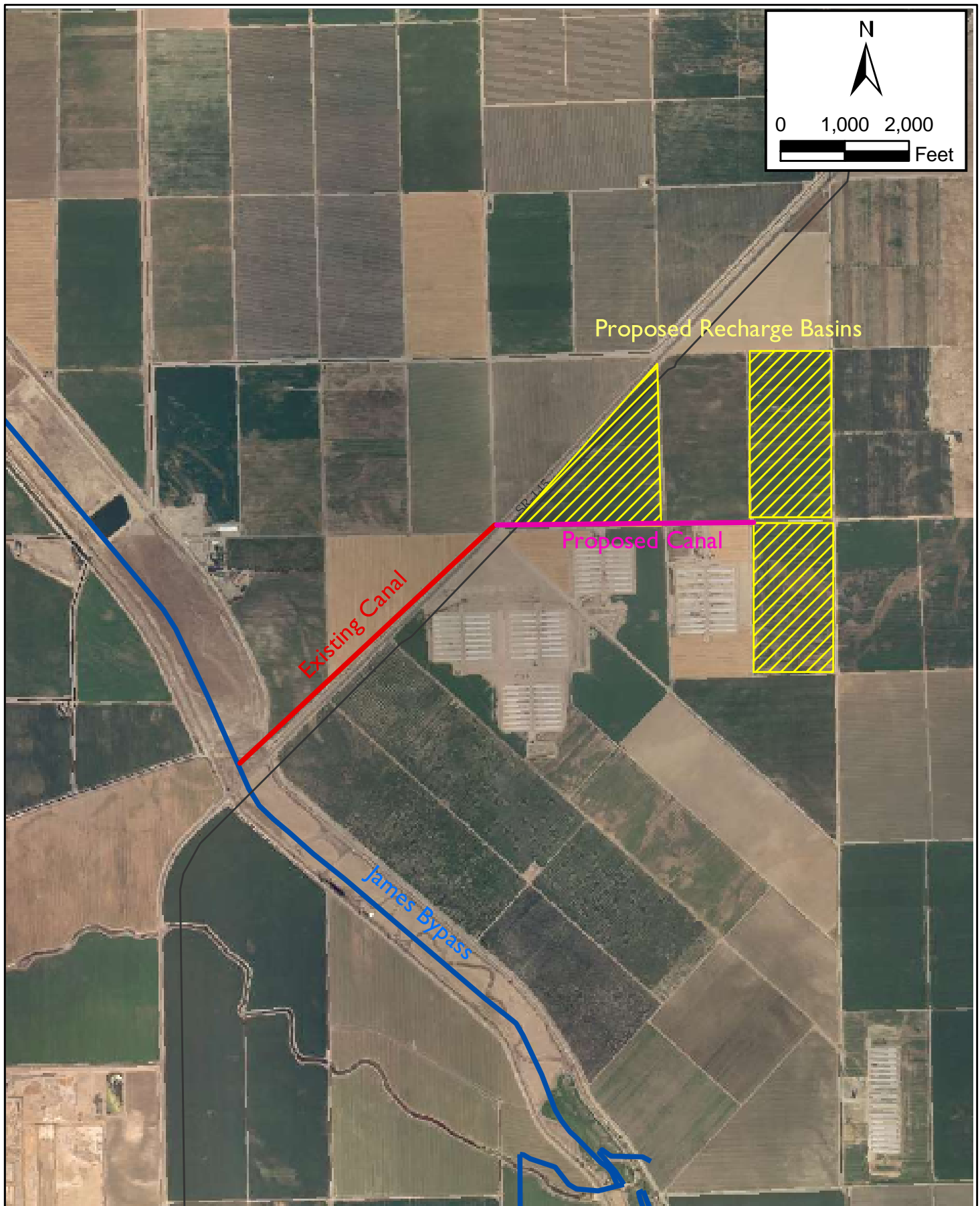
With support from DWR grant funding, additional hydrogeologic evaluations have been made of the sites since the completion of the draft feasibility study. In response to interpretation of the hydrogeologic evaluations, several recharge ponds have been proposed for development, as shown in Figure 4.4. These ponds can be operated using available floodwater. The proposed ponds are carried forward for inclusion in the GWMP components.

Raisin City Recharge Pond

For the Raisin City Recharge Project, Section 215 and other flood flow-related water would be routed through the Fresno ID canal system to Dry Creek Canal. Water in the Dry Creek Canal would then be piped to the Fresno ID/Raisin City WD border and then discharged into a canal. The canal delivers the water to an 80-acre groundwater-recharge basin constructed on land owned by the Raisin City WD. Figure 4.5 shows the conceptual design of the project. Water stored in the reservoir could be delivered to area growers for consumptive purposes or could remain in the reservoir to recharge the groundwater system.

Injection Wells

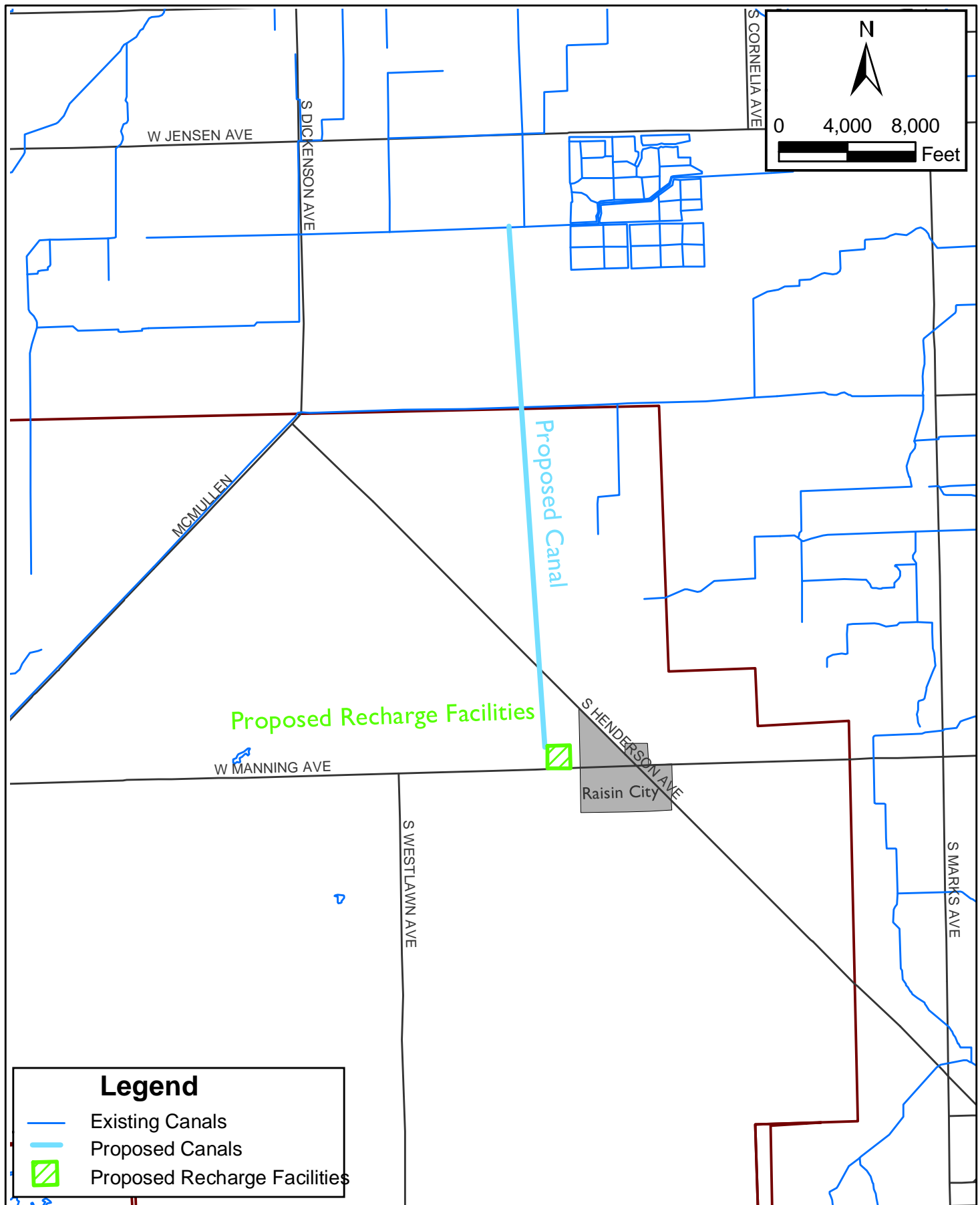
Injection wells pump water directly into the groundwater basin and are used primarily in urban areas, where land is at a premium, or in areas to provide hydraulic control in well-defined hydrogeologic and hydraulic conditions. Aquifer storage and recovery (ASR) projects can be quite complex and include multiple injection/extraction well systems. ASR systems often use treated water sources, such as municipal supplies meeting safe drinking water requirements, although, recently, the issue of disinfected byproducts has arisen as a constraint. The CVRWQCB regulates injection wells. Recently they denied projects that propose the injection of treated drinking water that meets standards due to issues associated with disinfection byproducts. Capital costs are high and include conveyance, treatment, and well construction. Given the high cost of ASR, the Lower Kings Basin hydrogeology, regulatory hurdles, and the presence of more viable and low cost options for increasing recharge, this option was removed from further consideration.



Lower Kings Basin GWMP Update
McMullin Recharge Project Area

April 2005

Figure 4.4



Lower Kings Basin GWMP Update

Raisin City Recharge Project with Water from FID Canals

April 2005

Figure 4.5

IN-LIEU RECHARGE

In-lieu recharge is the direct substitution of surface water or recycled water for groundwater. Groundwater not pumped and that remains in storage can be regarded as carryover storage, similar to the operations of a surface water reservoir. Surface water or recycled water can be substituted for groundwater in both urban and agricultural areas. Use of surface water in-lieu of groundwater pumping is a common practice in the Lower Kings Basin, but the accounting of pumping and in-lieu benefits has not been tracked and no management systems or criteria have been developed related to basin operations.

Agricultural In-Lieu Projects

In-lieu recharge is part of the Lower Kings Basin history of irrigation. The basin has successfully maximized agricultural in-lieu recharge opportunities that resulted from construction of Pine Flat Reservoir, as evidenced by the fact that there are no additional firm entitlements available for diversion during the irrigation season to meet the additional grower demands. The reliability and availability of additional surface water is the limiting variable for increasing agricultural in-lieu recharge within the Lower Kings Basin. Delivery, spreading, and recharge of floodwaters were previously discussed and are a GWMP component. New infrastructure for distribution and delivery of surface water to areas without existing infrastructure is not possible as a stand-alone program because new or existing surface water entitlements are not available for irrigation.

Additional in-lieu opportunities could be realized as part of a regional groundwater-banking and exchange project and a multiyear operating criteria designed to increase groundwater storage and levels. Successful in-lieu programs are often incentive based and would require the financial and political support of the community to construct additional distribution and/or to transfer or purchase water from other areas. In-lieu agricultural water supplies could be provided using recycled water from the City of Fresno, as further discussed below. In-lieu agricultural use is carried forward for further consideration as part of the GWMP long-term component and in context of regional banking and recharge.

Urban In-Lieu Projects

Urban in-lieu recharge consists of using surface water to meet municipal and industrial (M&I) demands and reduce reliance on groundwater. In-lieu benefits could be achieved through urban use of recycled water to meet nonpotable water demands. This is becoming an important option in the Upper Kings Basin, but has limited applicability in the Lower Kings Basin, where the urban areas are relatively small, not growing as rapidly, and in-lieu opportunities are not

currently economical because of treatment and conveyance costs. Even though urban areas, such as Lemoore, have existing distribution facilities or the means by which to construct them through connection and development fees, the cost of treatment and construction of large-scale conveyance to take surface water and treatment facilities are a major constraint.

Current participants in the GWMP planning effort did not identify any near-term needs or opportunities for taking surface water in-lieu of groundwater for urban in-lieu projects; therefore, this option was eliminated from further consideration.

REGIONAL GROUNDWATER BANKING

Groundwater depletion has created a potential reservoir of underground storage in the Lower Kings Basin. Other in-basin (within KRWA) or outside interests having surplus water could store water in the underlying basin during wet years for use in subsequent dry years. Groundwater-banking options could include regional partnerships with entities that would share in the financing of infrastructure improvements and projects and provide a portion of the project yield in return for use of the storage space.

Engineering constraints are similar to those of the local recharge ponds and include firmly defining sources of water; access to, or the need for, new or resized conveyance facilities; and acquisition of land for construction of large-scale spreading ponds. Institutional constraints are more restrictive and related to regulatory compliance, legal agreements and need for contractually binding assurances, lack of desire to open up the water rights to state hearings, need for operating and accounting methods to track and allocate banked water, and equitable cost sharing. Because storage space in the Lower Kings Basin is available, regional banking is feasible; therefore, the concept is carried forward for further consideration. Regional groundwater banking as part of an integrated long-term strategy is viable, and carried forward for inclusion as part of the long-term GWMP component.

Recycled Water

Recycled water can be a new source of in-lieu supply for direct use on crops, or may be recharged directly into the groundwater basin for storage. The regulations related to direct use of recycled water for agricultural irrigation are different from those currently being proposed for direct recharge of groundwater with recycled water. The level of treatment is the most important factor determining what type of uses can be accommodated (DHS 2001, RWQCB, 2004). Recycled water has a long history in California. The development of treatment technologies has improved the quality of recycled water and protected public health. The improved quality and the increasing need for new water sources have resulted in increases in recycled-water use.

State policies strongly support recycled-water use where it is cost effective, and recycled water is becoming an important component of an area's water portfolio. In addition, state funding through grants and loans also supports recycled-water use (Recycled Water Task Force 2003, SWRCB 2001, RWQCB 2004, SWRCB 2004).

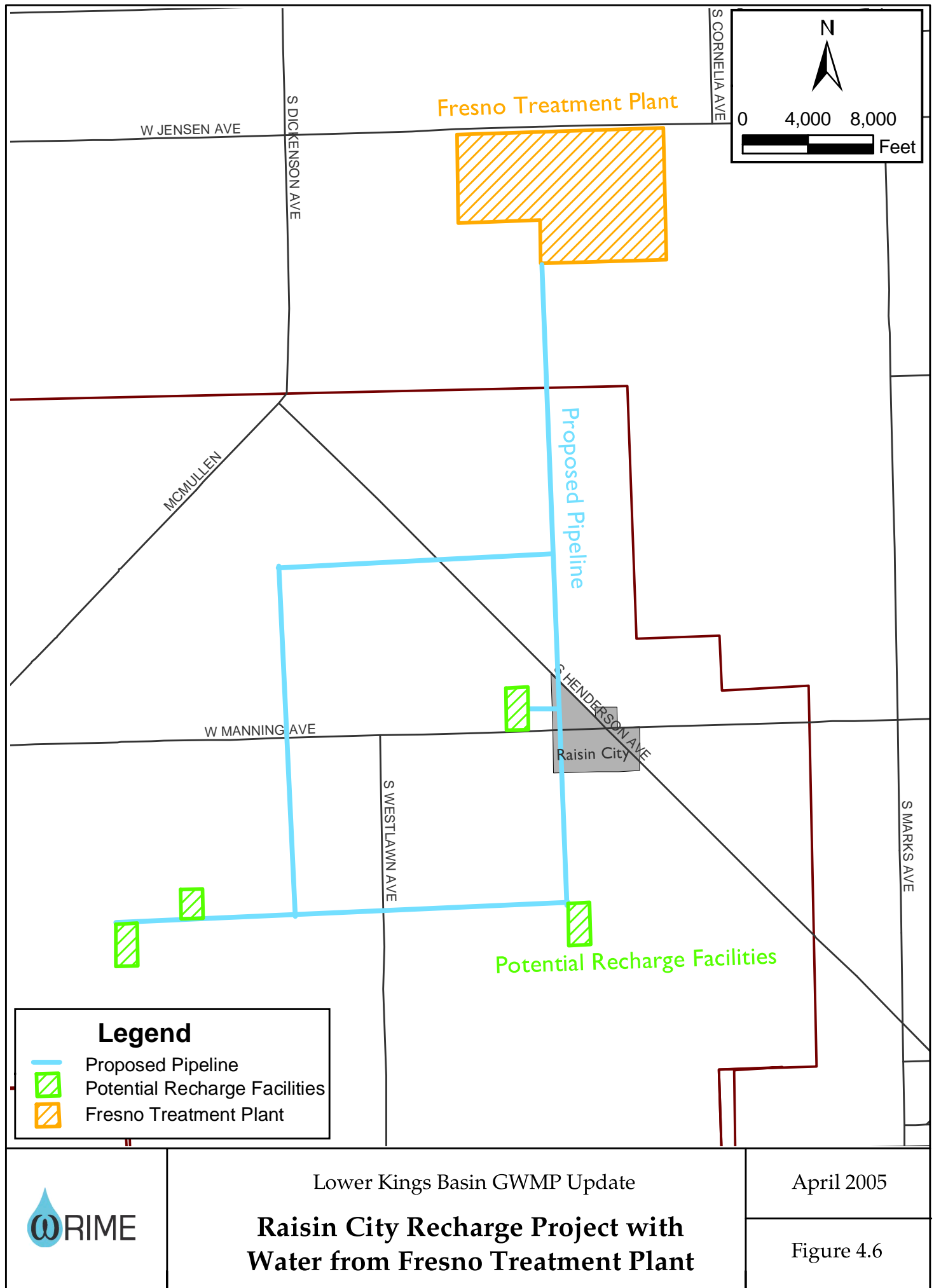
Opportunities exist for the use of recycled water from the Fresno/Clovis Regional Water Reclamation Facility (FCRWRF), located at Jensen and Cornelia in southwest Fresno. The FCRWRF treats 68 million gallons per day (mgd) (with a capacity of 80 mgd) (City of Fresno, 2005). The secondary treated water is directed to 1,660 acres of percolation ponds or to nearby farms for irrigation of fodder and fiber crops (City of Fresno 2005); the water is not disinfected. The current arrangement of percolation ponds has resulted in an undesirable mounding of groundwater that requires active management. At the same time, it is necessary to put as much treated wastewater to beneficial reuse as possible to balance the water budget and prevent regional overdraft (CH2M Hill 1992).

The feasibility of potential reuse projects for agricultural purposes in the Raisin City area has been previously evaluated (Provost and Prichard 1995) and four project concepts were developed. Figure 4.6 shows the conceptual layout and location of the proposed facilities. Table 4.1 shows the range of size and costs in 1995 dollars.

Table 4.1. Summary of Pipeline and Reservoir Options

	Description	Inflow (af/yr)	Recharge (af/yr)	Irrigation (af/yr)	Total Cost	Annual Cost (af/yr)	Overall Cost (af/yr)
#1	Pipeline & 1 Pond – 80 ac	7,728	3,205	4,521	\$2,952,650	\$37	\$67
#2	Pipeline & 3 Ponds – 160 ac	17,708	6,405	11,301	\$7,539,500	\$37	\$67
#3	Pipeline & 4 Ponds – 200 ac	28,667	8,004	20,661	\$12,352,025	\$37	\$67
#4	Pipeline & 3 Ponds – 960 ac	51,971	38,409	13,561	\$13,640,150	\$23	\$53

Both direct recharge and irrigation uses of recycled, secondary treated water were evaluated. The different scenarios put different emphasis on utilization of direct recharge (larger or more reservoirs), in-lieu usage (more turnouts and pipelines), or aerial extent of the program (loop layouts). Costs in 1995 dollars ranged from \$3 million to more than \$13 million. Along with design considerations for the pipelines and ponds, Provost and Pritchard also looked at groundwater mitigation (new basins in FID to offset exportation of recycled water), crop requirements (salinity levels and regulatory issues), and potential problems with existing agreements regarding the use of pumped reclamation water. Use of recycled water in lieu of groundwater pumping in Area A would leave water in storage in the groundwater basin and



provide for some water-level recovery, potentially reducing underflow from upgradient areas to the east. Such a project would also provide a consistent source of new water to the Lower Kings Basin, while also helping to reduce the undesirable mounding problems under the FCRWRF.

The opportunities for reuse of reclaimed wastewater in small cities within the Lower Kings Basin are limited because economies of scale limit the cost effectiveness of such projects. Additional treatment costs would be high, and distribution infrastructure to move the recycled water to areas of use is cost prohibitive.

A large-scale recycled-water project using FCRWRF water is feasible from an engineering standpoint, but institutional and economic issues are constraints to implementation. Regional and local costs and benefits require more detailed review. State funding is more readily available for such programs (SWRCB 2004) than in the past and may help offset costs associated with capitalizing such a project, especially because this type of multi-benefit, multi-participant project is a statewide priority. In addition, overdraft is being more widely recognized as a regional problem, and the current political climate may allow for a regional perspective toward recycled-water projects. The City of Fresno is in the process of updating its water master plan, urban water management plan, and groundwater management plan. Recycled water will be evaluated as part of this work, and Lower Kings Basin interests should be regarded as stakeholders in the process.

A recycled-water option as an in-lieu source of water or for direct groundwater recharge does not have any currently identifiable fatal flaws and is carried forward for further consideration as a long-term GWMP component.

4.3 OTHER POTENTIAL PLAN ELEMENTS

Additional program options were considered, including land acquisition, conveyance facilities, water conservation, groundwater monitoring, and data management.

LAND ACQUISITION

Access to land for construction of spreading ponds and recharge operations was identified as a constraint to development of recharge facilities. Land acquisition costs are relatively high, ownership of property changes quickly, and ready access to capital to purchase land when it is on the market has prevented some projects from moving forward. The ditch companies and water districts do not have capital reserves that would allow them to respond quickly. Land in the Lower Kings Basin tends to be in large parcels that infrequently come to market. Acquired

land could be leased back to a grower to continue production until final engineering and plans for needed improvements are completed. Condemnation of agricultural land for recharge purposes is also not politically desirable. A land-acquisition program could be localized within one irrigation district or ditch company, or encompass a larger area to achieve a more regional benefit. The concept is to have capital available to acquire property or easements for subsequent development as a recharge or spreading operation. Constraints to such a program include political acceptability, lack of funding capacity of the public water districts, lack of management structure to make quick decisions, high land costs and low property turnover rates.

A dedicated land-acquisition program, with a funding source and capital reserve element, would allow Lower Kings Basin interests to respond when opportunities for land comes on the market. The option has been carried forward for further consideration.

CONVEYANCE FACILITIES

As discussed in Section 2 and in the previous GWMPs, there are constraints associated with conveyance of water to lands where the water could be used or directly recharged. The purpose of improving existing conveyance structures or building new structures is to provide operational flexibility and improve conjunctive use opportunities. More or better conveyance would give greater access to alternative sources of water and allow water to be moved around the area for in-lieu or direct recharge.

Near-term water projects will resolve the conveyance capacity or wheeling issues for the proposed project. This includes completion of the feasibility study for the North Fork Group Recharge Project concepts, and upon final design for McMullin Group and Raisin City Recharge Projects. During final design, using existing canals, resizing canals for the final project, and identifying piped reaches will be considered. Agreements for use or improvements of existing facilities owned by other ditch companies or districts may be needed, or new rights-of-way and easements procured.

Conveyance issues and needs for longer term projects will require further evaluation for the specific projects, including those associated with development of in- or out-of-basin surface water and flood flows, and for in- or out-of-basin regional recharge, transfer, exchange, or banking. Additional large-scale conveyance facilities or major improvements to existing facilities would be considered as part of the project feasibility study.

Potential large-scale conveyance concepts were discussed by the BAP in general terms. The engineering issues surrounding the design of pipelines or conveyance facilities are relatively easy to resolve. Once the specific source and volumes of water is identified and lands for

application or percolation of the water are defined, designing the pipelines or canals to convey the water is relatively straightforward. Substantive constraints are more likely to be related to negotiating wheeling arrangements, cost sharing, procuring easements and rights-of-way, finding the land and water, and environmental compliance.

Concepts for large-scale projects discussed by the BAP and in previous evaluations were related to the following:

- Developing a Mid-Valley Canal or similar facility whose purpose would be to convey water from the Mendota Pool or the San Joaquin River to WMA A, WMA B, and/or WMA B2;
- Developing new facilities (lined canal or pipeline) or lining existing canal facilities to convey Kings River floodwater or Friant 215 water from Upper Kings Basin areas through FID or CID; and
- Developing new facilities (lined canal or pipeline) or improving existing canal facilities in the Lower Kings Basin to accommodate larger recharge projects.

One of the primary constraints to purchasing 215 water when it is available is related to the systems losses between the available points of diversion and point of delivery to the Lower Kings Basin. Lower Kings Basin stakeholders have been reluctant to pay for this water because losses in the upper Kings River reaches can limit delivery efficiency. A conveyance facility to transfer 215 floodwaters would make purchase of the water more attractive because a facility would reduce conveyance losses and ensure delivery of water to the place of use or recharge. The cost for improved or new facilities would add to the cost of the water; therefore, the cost effectiveness of new facilities or improvement to existing facilities needs further analysis and comparison. A more detailed evaluation of existing and proposed facilities should be part of any proposed engineering feasibility study; such work is proposed for inclusion in the GWMP implementation effort.

WATER CONSERVATION

Water conservation could allow a water supplier (e.g., water district, city, ditch company) to delay or reduce capital investments required for expansion of water supply facilities. Before seeking to develop additional supplies or obtaining funding from state or federal sources, water-conservation programs are needed to demonstrate that existing water uses are efficient. It is important to note that in the Lower Kings Basin, in the area where clay layers are not present, the water that is applied in excess of crop water requirements percolates to the groundwater basin and is stored for subsequent use. Intentional spreading and over application of surface water at times when it is available is part of the conjunctive use program and is a beneficial use. The benefits of water conservation are related primarily to leaving water in groundwater storage, and reducing stream diversion or releases from reservoir storage when

such actions could have a negative impact. In addition, water conservation that increases the efficiency of applied water may reduce diversion requirements and allow more water to be conveyed to another place in the basin for exchange, banking, use, or transfer. Water conservation is an option that will continue to be part of the GWMP and overall water management strategy in the Lower Kings Basin.

GROUNDWATER MONITORING

Groundwater levels in the Lower Kings Basin have steadily declined since the 1950s. Local agencies, KRCD, DWR, and USBR have measured and/or are currently measuring groundwater levels as part of existing monitoring programs. DWR has aggregated some of the measurements and makes them publicly available at the State Water Data Library². KRCD uses the available data from DWR and local sources to prepare its annual report.

The current groundwater level monitoring program includes semiannual groundwater level measurements of over 50 wells (exact number varies from year to year). Water level measurements are typically taken in October and April to measure the range of groundwater levels occurring after and before the irrigation season. It is not clear whether the data (i.e., both the frequency of measurement and the spatial adequacy of the monitoring-well network) are sufficient to determine project benefits that may be accrued as a result of GWMP project implementation. There may be opportunities to increase the information value and decrease the monitoring program cost.

The sufficiency of monitoring-well networks has not been evaluated in detail. A quantitative approach in which numerical ratings are assigned to monitoring wells on the basis of data uncertainties (e.g., availability of well construction information) and as used by USGS, could be used to evaluate the Lower Kings Basin monitoring-well network. This type of analysis could be expanded to include aspects of how the data are collected and used. Well ratings should be spatially evaluated so that potential data redundancies and adequate distribution can be determined. The groundwater monitoring network could also be evaluated using an integrated groundwater and surface water model. An integrated model currently proposed for development in the region. Since the model will achieve many objectives of KRCD in the Lower Kings Basin, criteria for evaluating and designing the network should include evaluation of whether the network provides optimal data for verifying model accuracy and using the model sensitivity (or lack thereof) to determine the number of groundwater wells needed in a particular area.

² <http://www.well.water.ca.gov>

Water Resources Data Management System

The efficiency of the process by which KRCD obtains groundwater level data can be improved and standardized by developing a data-management system for groundwater and water-resources data. A Kings River Basin Groundwater Data Center (GDC) could provide for a centralized interactive groundwater information resource that provides access to groundwater data collected and shared by agencies throughout the Kings River Basin. The Kings River Basin GDC is viewed as the foundation for groundwater management efforts to be implemented in this GWMP and is recommended to support the groundwater management activities of the Kings River Basin.

Currently, there is no centralized groundwater information source that is locally operated and maintained. Monitoring efforts undertaken by the agencies within the Kings River Basin generate data that are stored in separate databases or hardcopy format. The GDC would become the repository for groundwater data and other water-resources information, and would facilitate groundwater analyses essential to the groundwater management objectives of the Lower Kings Basin. The GDC could assist in public outreach because it could be designed as an Internet-based tool. Water agency staff, industry professionals, decision makers, and the general public could have access to groundwater data and historical semiannual reports.

4.4 GROUNDWATER QUALITY PROTECTION OPTIONS

The GWMP must contain components related to a) groundwater-quality degradation and b) changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin (CWC 10753.7. [a]).

In addition, a groundwater management plan may include water-quality options (CWC 10753.8) relating to: a) control of saline-water intrusion, b) identification and management of wellhead-protection areas and recharge areas, c) regulation of the migration of contaminated groundwater, d) administration of a well-abandonment and well-destruction program, e) identification of well-construction policies, and f) construction and operation by the local agency of groundwater-contamination cleanup.

The mandatory and voluntary options were evaluated by the BAP in developing the final GWMP water-quality component. The BAP considered the overall review of water-quality options as falling into three categories that included programs to: 1) develop new regulatory programs to protect water quality, 2) develop new voluntary and cooperative efforts to protect water quality, or 3) work to better integrate and improve existing programs and interagency relationships.

The policy direction provided by the BAP was to define the programs where ongoing activities met the requirements, and to focus on programs where existing land use and water-related agencies were already working. The intent is to avoid duplication of effort, increase efficiency, and avoid cost increases. The opportunities for further coordination are identified, and KRCD and the BAP will continue to identify opportunities to obtain funding or technical support for programs that would assist agriculture in complying with existing requirements instead of developing additional regulatory burdens or new programs. Program integration and interagency cooperation is an option carried forward. The justification and support for the BAP decision is presented below, along with how the options would be integrated to meet the water-quality protection objective of the GWMP.

Existing regulatory programs are briefly described below to assist Lower Kings Basin stakeholders in understanding the complex regulatory compliance requirements that would serve to both protect local GWMP recharge projects once built, and constrain implementation of locally sponsored projects. Current programs for water-quality protection are managed primarily by Fresno County, Kings County, RWQCB, DHS, and the California Department of Pesticide Regulation (DPR).

PREVENT GROUNDWATER QUALITY DEGRADATION

The GWMP must contain components related to groundwater-quality degradation (CWC 10753.7. [a]). The BAP decided to eliminate from further consideration any new regulatory programs for control of saline migration, the migration of contaminated groundwater, well drilling or construction, or wellhead protection and protection of recharge areas. Such regulation may be considered at a future time to protect water quality and any investments in recharge projects. KRCD is not a regulatory agency and is not tasked by the Board with regulating contaminants or land uses that could cause contamination. None of the other participating water districts or ditch companies has land use or contaminant control responsibilities or regulatory powers. These agencies are reliant on other local, state, and federal programs to ensure protection of water quality. Neither KRCD nor any of the GWMP participants seek to develop new regulations or requirements in context of the GWMP. Emphasis is placed on ensuring GWMP proposed projects would comply with existing local, state, and federal regulations and would not impair surface water or groundwater quality. The GWMP also will seek to integrate local efforts with existing programs to control contaminants.

CHANGES IN SURFACE WATER OR GROUNDWATER FLOW AND QUALITY

The GWMP must contain components related to changes in surface water flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater

pumping in the basin (CWC 10753.7. [a]). In addition, one of the voluntary components is associated with regulation of the migration of contaminated groundwater. These requirements are met through program integration. KRCD and local stakeholders will also ensure evaluation of any potential impacts during the feasibility study or when complying with the California Environmental Quality Act (CEQA).

There are a number of GWMP options that could change the surface water flow regime to enhance groundwater recharge and conjunctive use. None of the proposed options are anticipated to influence surface water quality. It should be noted that some of the proposed GWMP options could result in increased flows down the Kings River and provide ancillary environmental flow benefits to the fisheries management program. The benefits are related to the volume, timing, and quality (temperature) of the flow.

The purpose of some of the GWMP options is to positively affect groundwater level by increasing storage in the groundwater basin. This is considered a project purpose and benefit. Increased water levels as a result of intentional recharge are not anticipated to have any negative impacts to groundwater quality because the quality of existing surface water is good and the surface water is suitable for both direct agricultural use or for beneficial use as a source of groundwater recharge. Initially, percolation could mobilize salts and nutrients and this would be evaluated based on site-specific conditions. It is expected that the recharge operations, as currently conceived under any of the GWMP options, would provide benefits related to recharge of clean surface water, which would improve baseline groundwater quality in areas with high total dissolved solids (TDS) or nitrates.

Changes in groundwater levels could result in changes to groundwater flow rates and directions and this could cause migration of poor-quality water, although such effects could result in either negative impacts or benefits. In Area A, the BAP identified that there is some migration of high TDS water from the west into the planning area. Raising groundwater table elevations in Area A would serve to reduce or reverse the migration of poor-quality water into the planning area.

No known plumes of poor-quality water have been identified that would be affected by groundwater recharge for near-term projects as currently proposed, but this would need to be further evaluated based on more specific project operations and in more detailed environmental review. CEQA review would be conducted when more detailed project proposals are prepared and projects are ready for decision. When specific projects are put forth, the KRCD or designated lead agency will be required to coordinate with other responsible and trustee agencies, including the local cities, counties, and state agencies, to ensure that impacts are avoided, minimized, and mitigated to the degree possible.

Feasibility studies of the specific projects are being conducted or are proposed. Future review will be needed to ensure that any of the proposed changes in the recharge or discharge of surface water and groundwater, changes to operations of existing facilities, or construction of new facilities will not cause negative affects to existing water quality, water users, or the environment. Such studies, when completed, will also help the lead agency comply with CEQA, obtain any needed permits, and obtain voter approvals for funding.

The water level-monitoring component of the GWMP, coupled with the KRCD annual report, will assist the KRCD Board and BAP in tracking the occurrence and movement of flow and how it may affect the migration of poor-quality water.

AB 3030 WATER QUALITY RELATED OPTIONS AND PROGRAM INTEGRATION

To meet the intent of AB 3030 and SB 1938, the following voluntary elements were considered for inclusion in the GWMP. These areas are identified as opportunities for program integration between the local and state agencies and the Lower Kings Basin stakeholders, and KRCD will continue work cooperatively with other public entities that have jurisdiction and authority. The elements considered are as follows:

- Control and monitoring of land subsidence,
- Control of saline-water intrusion,
- Identification and management of recharge areas and wellhead-protection areas,
- Well drilling and construction, and
- Construction and operation by the local agency of groundwater contamination cleanup.

Land Subsidence Management Options

Land subsidence is an irreversible occurrence and can adversely affect infrastructure throughout a region (e.g., cracking and breaking pipes, separating wellheads from the ground surface, cracking canal channel bottoms). The optimal management practice for land subsidence is to prevent it from happening by sustaining water levels. Further land subsidence can prevented in the Lower Kings Basin by increasing the amount of stored groundwater, maintaining water levels, and manage its extraction. This can be accomplished by implementing management options that are to be included in GWMP components. All of the near- term and long- term actions that are being proposed that are part of the conjunctive use program will also benefit the basin by reducing he potential for land subsidence.

The overall monitoring program should include land subsidence elements. KRCD should work with other interests in the San Joaquin Valley and surrounding groundwater subbasins to

monitor regional subsidence by installing extensometers. An extensometer is an instrument that measures changes in land surface elevation due to the compression of clay layers in the groundwater system. USGS and DWR measures land subsidence in areas west and south of the Lower Kings Basin using extensometer. The Lower Kings Basin BAP could approach USGS and DWR about the installation of extensometers in the Lower Kings Basin. Other actions related to monitoring subsidence are discussed in the Implementation Plan.

Control of Saline Water Intrusion and Regulation of the Migration of Contaminated Groundwater

There are potential issues with water in the western part of the Lower Kings Basin that has elevated concentrations of TDS, but the BAP did not identify any insurmountable constraints to beneficial use. The mound of water under the FCRWRF also has elevated concentrations of TDS. In the southern part of the Kings River Basin, growers reported high levels of alkalinity in the groundwater. Both situations require ongoing monitoring but no major new programs or regulations are proposed to further control the migration or buildup of salts because beneficial uses have not been impaired. Additional monitoring to identify long-term trends and problems is recommended for inclusion in the GWMP. Existing Drinking Source Water Protection Programs and associated monitoring of urban water and domestic wells will also provide data to aid in reviewing the need for further action.

Management of Recharge Areas and Wellhead Protection Areas

Regional recharge characteristics were evaluated as part of this study. Management and development of recharge areas is part of the GWMP, and the GWMP identifies potential recharge areas for project development. Land acquisition is one of the options discussed in this GWMP for protecting these recharge areas and land acquisition by Lower Kings Basin stakeholders would protect recharge areas from future development.

DHS has established the Drinking Source Water Assessment and Protection Program (DSWAPP) to provide information so that communities can develop programs to protect drinking-water sources. The DHS DSWAPP is intended to implement federal wellhead-protection requirements, which includes identifying the wellhead protection zone. The wellhead protection zone is the area that contributes water to a municipal well. The program includes identifying and managing potential contaminants from land uses that are above the wellhead protection zone area. DHS has worked with local water purveyors to map and identify risks to sources of drinking water. The DHS program, in concert with local well-drilling and construction regulations and the existing land use plans, serves to implement wellhead protection at the local level and no further programs are included in the Lower Kings

GWMP. As previously cited, other state agencies with authority to control actual or potential sources of contamination are DPR, RWQCB, and SWRCB.

Land Use Controls to Protect Recharge Areas

Controlling and managing land use is important for protecting recharge areas, wellhead-protection zones, and water quality. The state does not have land use planning authority and therefore cannot control land use. Land use controls and decisions are the responsibility of cities and counties. At the local level, the cities and counties use their land use planning authorities, police powers, and local codes and regulations to protect water quality and recharge zones.

Fresno County Programs

The Fresno County General Plan (Fresno County, 2000) guides land use and development and contains the County water-quality protection goals. The Open Space and Conservation Element defines County goals, policies, and programs to protect water quality and groundwater resources. The Fresno County General Plan contains important policies for protecting recharge zones. Any new development, including any proposed Lower Kings Basin recharge and conjunctive use facilities, would be interpreted by Fresno County under these goals and policies.

The County also has a range of ordinances and local regulations to support water-quality protection and implement the General Plan. Fresno County Public Works and Planning Department is the local agency with responsibility for land use planning and environmental protection. The agency supports the Fresno County Board of Supervisors in setting and enforcing land use and contaminant-source control policies of the County General Plan and the various County Codes and Ordinances.

The Fresno County Health and Safety (Title 8) contains numbers chapters to regulate potentially contaminating activities and waste products, also defining the health authorities and permitting process³. The Resources Division is tasked with oversight of disposal sites, solid waste, recycling, and coordination of special districts. Fresno County Department of Planning and Public Works, Development Services Division, coordinates building permits, code enforcement, environmental analysis, General Plan, inspection, plan checks, planning, site plan review, zoning, and water/geology programs.

³ Chapter 8.20 Garbage and Rubbish Disposals; Chapter 8.22 Unauthorized Dumping; Chapter 8.24 Waste Disposal; Chapter 8.28 Industrial Wastes; Chapter 8.30 Land Application of Biosolids; Chapter 8.50 Environmental Health Permits and Inspection Fees; Chapter 8.60 Storage of Hazardous Substances In Underground Tanks

Kings County Programs

Within Kings County, the local Planning Department directs the preparation and implementation of the County General Plan (Kings County 2004), adopted in 1993 by the Kings County Board of Supervisors and most recently amended in January 2004. The resource-protection element of the General Plan states that the objective of the County is to protect groundwater quality by applying development standards that seek to prevent pollution of surface water or groundwater and net loss of natural water features (Objective 11.2). Specific policies are established to protect groundwater by requiring the installation of wells in conformity with the California Water Code, the Kings County Well Ordinance, and other pertinent state and local requirements (Policy 11d). These policies and regulations would affect conjunctive use projects proposed in Kings County.

Continued coordination with the County is needed to ensure compliance with the County General Plan and ordinances. No additional options or components are to be included in the GWMP.

Well Drilling and Construction

The voluntary options that may be included in the GWMP include programs for administration of a well-abandonment and well-destruction program and for identification of well-construction policies. Within Fresno County, the Department of Planning and Public Works, Development Services Division, also coordinates building codes and the water/geology programs, including the well-drilling and permitting process. Codes pertaining to water and sewage (Title 14) contain the County well regulation (Chapter 14.04) and well-construction and destruction standards (Chapter 14.08), which implement the state well standards at the local level and define well development, sealing of wells, sampling, and permitting requirements. The County Code defines the County's role and responsibility in groundwater management (Title 14, Chapter 14.03), which is limited primarily to control of groundwater exports from the County.

Kings County also has well-drilling and construction standards. Continued coordination with the Counties is needed to ensure compliance with the County ordinances and requirements. No additional options or components are to be included in the GWMP.

This section provides an overview of funding and governance options that were discussed by the BAP at the March 2004 meeting. In the past, the Lower Kings Basin stakeholders worked cooperatively with others in the region to fund and construct Pine Flat Reservoir. The cooperative approach to the management of the surface water resources and Pine Flat Reservoir continues through the KRWA. More recent history related to groundwater management demonstrates the independent nature and spirit of the water agencies, land owners, and ditch companies, and the tendency to work within their own jurisdictions to fund and to resolve problems. The independent character of the agricultural community and agencies is part of the cultural, economic, and political heritage of the region. The independent nature has also created fragmented governance and management of the groundwater resources and has been a contributing factor in the basin overdraft.

Within the latter half of the 1990s and with support of KRCD, the different agencies began to take steps to work together and resolve groundwater problems by preparing groundwater management plans for their respective areas. The independent plans have not resulted in approval, funding, or construction of any large scale conjunctive use projects, or in resolution of institutional issues that constrain conjunctive use. To update the GWMP, the BAP decided to prepare an integrated GWMP in recognition that the groundwater basin is integrally connected, and that the previous fragmented approach to managing groundwater has not produced a consensus or a solution. The BAP also recognized that to effectively solve overdraft, a different approach to management and governance of the groundwater basin should be considered.

This section evaluates alternative funding and management approaches. The GWMP is a step toward greater collaboration and cooperation among the Lower Kings Basin agencies and agricultural interests, and is a step towards developing a broader base of political and financial support. Increased cooperation, alternative institutional arrangements, and a different organizational model may be needed to implement local projects, improve groundwater management, prevent conflicts, and meet the GWMP goals and objectives. To be effective and minimize costs, management of the groundwater basin will require efficient and equitable administration of the GWMP.

5.1 BAP ISSUES AND PLANNING PRINCIPLES

At the first BAP meeting on November 15, 2004, issues and concerns related to the groundwater management plan and conjunctive use program were identified. Issues were identified and characterized as Policy or Management, Technical/Engineering, and/or Economic. Table 5.1

presents the list of issues and concerns. It is clear that many of the issues surround costs, economics, and management of the groundwater.

Table 5.1. Issues and Concerns

ISSUES AND CONCERNS	Policy	Technical	Economic
Lack of faith and uncertainty in the ability of the legal system to protect overlying and agricultural water rights	X		
Agricultural versus urban interests—agricultural areas have a limited ability to compete with urban areas because urban areas have a high ability to pay and a large voting block	X		X
Need to preserve local control, fear loss of control, locals must lead the effort	X		
Agriculture economic and limited ability to pay higher water rates			X
High water levels in upper Kings River Basin around the Fresno wastewater plant	X	X	X
Reclaimed water costs for agriculture are unrealistic			X
Low water levels in the area of Raisin City and underflow to the area impacts surrounding area		X	
Potential for litigations is high. Resolving groundwater issues with lawsuits would cost a lot of money, take a lot of time, and should be avoided	X		
Limited understanding on how the groundwater basin works, water budget, and flow between areas		X	
Overdraft in capital letters		X	
Reluctance to consider “regional” solutions	X	X	
Limitations in the amount of “free” or “unallocated” water to solve the problem and provide additional recharge	X	X	
Adequacy of existing facilities to move water to areas for use or recharge		X	
Increasing pumping costs and depth to water			X
Relationship between levels and quality needs analysis—migration of poor-quality water from the west and south		X	
Available recharge water comes in big floods of short durations—“trying to manage a fire hose with a thimble”	X	X	
Infrastructure constraints, lack of capacity, need for wheeling agreements to move water	X	X	
Competition for available supply—everyone is fighting for flood flows	X		
Underflow from other areas to overdrafted in Raisin City area creates political issues with neighbors	X	X	
Avoid state intervention and court proceedings—costly and slow process for solving problems	X		
Seek a physical solution instead of lawsuits	X		
Prevent interference with overlying rights	X		
Need for adequate technical information and data to locate and design projects		X	
Suspicion of government’s ability to provide solutions	X		

In terms of financing, the BAP consensus was that any project costs should be borne by the entities that receive the benefit, and benefits should be quantified and demonstrated through engineering and economic analyses before anyone is asked to pay or bear increased costs.

Regarding governance, the BAP clearly stated that local control must be preserved, but it was generally recognized that there needs to be some type of institutional arrangements and a management structure to fund and implement the GWMP projects.

5.2 FINANCING

Current funding approaches for the overlying irrigation districts are briefly discussed to identify funding and financing opportunities. The GWMP includes monitoring, feasibility studies, design efforts, and other management actions that represent on- time, up front cost. The development of new water supplies and the necessary infrastructure is a major financial undertaking that will require debt service. The GWMP provides a general overview of potential funding sources, programs, and project partnerships available from federal, state, and local sources

Local resources need to be dedicated to implement projects and programs identified in the GWMP. State and federal grants may provide one opportunity to fund some activities, such as planning, feasibility study, and design work, but some programs such as monitoring and annual reporting require ongoing, stable funding from local sources.

Low-interest loans may be available for capitalizing new facilities, acquiring land, and constructing projects but local money would still be needed to retire debt and for operations and maintenance. It is necessary for the BAP and its member agencies to identify local revenue to leverage outside funding from state and federal programs. Once the capital facility project costs are more firmly defined, the distribution of costs to local interests will need to be established based on the distribution of the anticipated benefits. The distribution of costs and benefits will need to be documented through engineering and economic evaluations. The information will be needed before holding an election to seek approval of proposed assessments or fees. Increasing benefits assessments or fees by any of the overlying water or irrigation districts will likely require further studies and a special election pursuant to state law as defined by Proposition 218.

FUNDING SOURCES

Federal Funding

Federal funds can be made available to KRCD and KRWA member agencies through a variety of mechanisms, including subsidies, appropriations, in-kind services, grants, loans, and cost-sharing agreements. The following processes described how to securing these funds.

Legislative Approach

Federal funding can be secured through the legislative process to directly fund an approved project. KRCD and/or KRWA, working with a local congressional representative, can begin this process. The project may require the establishment of federal interest through an act of Congress and then be funded in subsequent years. An appropriation can be made the same year if the project is consistent with the goals and objectives of an existing federal program. Competition for Congressional funds is formidable and requires broad support of local, regional, and state interests for projects to be successful in obtaining funding.

Federal Agency Interest

Funding can also be secured for projects directly from federal agencies. Local projects may be consistent with the goals and objectives of an agency and eligible for funds and in-kind services through directed actions and partnerships. Federal agencies commit to projects during their respective internal budgeting processes and have the flexibility to disperse funding over several years. KRCD had several partnerships with the U.S. Bureau of Reclamation (USBR) and the Corps. Both agencies have experienced funding reductions in recent years so the ability to partner with local agencies has been limited.

Federal Assistance Programs

A third option is to apply for project funding under an existing federal agency grant, loan, or assistance program. Potential partnering agencies include the USBR, U.S. Environmental Protection Agency (EPA), the Corps, United States Department of Agriculture (USDA), U.S. Fish and Wildlife Service (USFWS), and USGS. Eligibility, cost sharing, and application requirements vary among the programs.

State Funding

State funds are similar to the federal funding mechanisms. The availability of state funds for water-resources projects is a reflection of the current fiscal climate. Propositions 13 and 204 have demonstrated the state and voter commitment to supporting locally sponsored groundwater recharge facilities and studies. Voter approval of Proposition 50, the \$3.4 Billion Water Security, Clean Drinking Water, and the Coastal and Beach Protection Act of 2002, is funding a variety of water resources–development programs. These programs include CALFED, Integrated Storage Investigations, and other grants and loans for groundwater recharge construction projects.

Legislative Approach

Although the dollar amounts available from the state are usually not as substantial as federal funding opportunities, the state legislative process is somewhat more straightforward. Appropriating funds through the state legislature is extremely competitive and subject to the state budget conditions.

State Agency Interest

Discretionary funds may be available in the form of directed action assistance or in-kind services. Partnerships with agencies such as the DWR Division of Planning and Local Assistance (DPLA), Department of Fish and Game, and CALFED may yield monies and services. The current MOU for the NFG is an example.

State Assistance Programs

Finally, a third option is to apply for project funding under an existing grant, low-interest loan, or assistance program administered by any of the various state agencies. Under Proposition 13, the Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act of 2000, approximately \$200 million statewide for groundwater management and recharge projects was provided through the DWR DPLA. Similarly, Proposition 13 provided a major source of funding for the CALFED Bay-Delta Program and other such programs administered by SWRCB. Proposition 50 provides an opportunity for funding groundwater recharge related capital facilities and both Planning and Implementation grant funds are available for project development and construction, respectively.

Local Funding

Local funds are available to city and county governments from a variety of sources including general funds, water rates, developer fees, connection fees, capital improvement programs, acreage or *ad valorem* assessments, and taxes. Local funds can be raised by individual water agencies and districts, or by the counties for more regional efforts. These funds could be generated by assessment, sales taxes, water service fees, developer fees, and by groundwater banking and transfer-related contracts. It is important to note that Proposition 218 creates specific procedural requirements for special districts related to generating fees and assessments, and that any efforts to generate new charges and assessments would be subject to voter approval. Planning or construction of new facilities requires additional evaluation of benefits and costs and an electoral process, as defined by the proposition and amendments to state law. Private ditch companies can generate local matching funds directly from their shareholders without an election.

Funding Trends

A number of key trends can be observed related to state and federal funds and these will most likely influence local access to outside sources of funds.

- State and federal deficits. Deficits have reduced the availability of general-fund revenues to the agencies that previously provided technical support and funds for water-project development.
- Reduced state and federal grant and loan funding. Many state and federal programs for grant and loan funding have been curtailed as more pressing social needs redirect funds.
- Bond funding of studies and planning. Previously, Propositions 204 and 13 provided a source of money for groundwater investigations, project construction, and groundwater management plans. These funding sources have been depleted. Proposition 50 is a source of funds for continued support but contains unique and new requirements.
- Local and special district budgets redirected by the state. The state budget deficit has led to the state diverting funds from both local city and county governments and, more recently, from special districts.
- Increased requirements for generating special district fees and assessments. Proposition 218 did for special districts what Proposition 13 did to local government *ad valorem* taxes. Any new fee or assessment requires voter approval and compliance with legislative and constitutional mandates to conduct the election, and engineering studies to prove benefits and distribute costs.
- State move toward fee-based revenue for service. Reduced general-fund revenues have put the burden on state agencies to increase fees for service such

as water-rights permits, dam safety, and other payments by the regulated community.

- Increased competition for grant and loan funds. Reduced local government revenues increase competition for any sources of non-local funds.
- Beneficiary pays principal. Large state and federal programs, such as CALFED, are requiring detailed economic analyses that document who receives project benefits and how payment for program implementation is to be distributed.

5.3 MANAGEMENT AND GOVERNANCE

METHODS OF GROUNDWATER MANAGEMENT IN CALIFORNIA

DWR has identified six methods of groundwater management in California. They are listed below along with the identification of management authority and extent (*parenthesis*) in the chronological order in which they have been developed:

- Overlying Property Rights (*property owner*)
- Statutory Authority (*legislatively defined local agency or district*)
- Adjudicated Groundwater Basins (*groundwater basin, water master or court*)
- Groundwater Management Districts or Agencies (*legislatively defined local agency or district*),
- Groundwater Management Plan (AB 3030, SB 1938) (*local agency or district*),
- City and County Ordinances (*city or county*).

Based on this list, it is apparent that there can be overlapping jurisdictions and approaches to groundwater management. If groundwater management is not developed appropriately, the presence of multiple jurisdictions can lead to complicated and potentially conflicting groundwater management approaches within a basin.

In California, surface water and groundwater rights are separate and distinct. This has an influence on how the resources are governed and managed at the local level. A permit application process for appropriating surface water in California is contained in the California Water Code. The California Water Code does not authorize the State of California to manage groundwater; therefore, groundwater rights have evolved through a series of court decisions dating back to the late 1800s. Recently, through legislation and as supported by bond funding, DWR has helped local entities develop local groundwater management plans, groundwater related projects, and conjunctive use strategies. These are discussed further below.

KINGS BASIN GROUNDWATER MANAGEMENT

Although there is currently no groundwater management authority in the Kings Basin, groundwater management is practiced primarily through exercise of the overlying property rights and through development of local groundwater management plans by the local water districts individually or working through KRCD. Small groundwater recharge projects and conjunctive use of surface and groundwater sources is being practiced by individual districts and mutual water/ditch companies, or groups of districts within the basin through cooperative agreements such as the McMullin Group and NFG.

Local surface water is managed under a system of agreements and entitlements coordinated by the Kings River Water Associations (KRWA). KRWA demonstrates that local entities can resolve long standing disputes and there is a history of surface water management, but no similar institutional arrangements are in place to locally manage groundwater resources.

KRCD does not have legislative groundwater management authorities and provides services and support only when requested. Their role has been primarily one of coordination rather than of active governance or management of the groundwater basin. KRCD has been very active in supporting local water management districts and ditch companies to obtain state funding and develop local GWMPs, conduct technical studies, and construct groundwater recharge projects when opportunities have arisen.

Groundwater management of the Lower Kings Basin has been primarily through development of AB 3030-related GWMPs covering independent parts of the region that were developed under a number of cooperative efforts implemented through MOUs or agreements. In general, water interests in the Lower Kings Basin have not historically governed, managed, and operated the groundwater basin in an integrated manner.

POTENTIAL APPROACHES FOR THE LOWER KINGS BASIN

Management opportunities and constraints in the Lower Kings Basin GWMP are discussed below, along with potential approaches to improve collaboration and cooperation. The GWMP and BAP recognize that projects developed by consensus through a collaborative process have the potential to both retain local control of the groundwater basin, and to increase the likelihood of success for project implementation. Implementation of the GWMP and local control can best be achieved by continuing to develop a broad base of political and financial support. In the near-term, existing structures of governance and management are to be used to pursue local projects within each of the WMAs. In the long-term, more formalized agreements between existing management entities will be further considered by the BAP and local stakeholders to

fund and implement regional facilities, should such facilities prove to be cost effective and provide benefits to the Lower Kings Basin.

The GWMP outlines the goals and objectives for managing groundwater resources in the Lower Kings Basin and addresses how individual stakeholders will work with each other to meet regional objectives. The BAP did not want the GWMP to include or address new rules, procedures, and regulations on water and land owners overlying the basin, or any mandatory measure to ensure that individual groundwater management efforts are also beneficial to the groundwater basin as a whole.

This discussion outlines possible collaborative processes and organizational structures to allow all individual users and districts the authority to implement the GWMP and meet the BMOs. A longer term strategy for governance should be considered so that work is done collaboratively to meet the regional goals outlined in this GWMP while, at the same time, allowing stakeholders to meet their individual groundwater needs.

Two major management processes are outlined below—the **individual interest-based model** and the **mutual interest-based model**. The individual interest-based model represents the historical management of groundwater in the Lower Kings Basin. The following text describes the two models in more detail and the advantages and disadvantages of each model. A governance model can be combination of the two so that the advantages of regional water management are realized without individuals feeling a loss of control over local management.

INDIVIDUAL INTERESTED-BASED MODEL

Under the individual interested-based model, stakeholders would govern and develop water resource projects individually. This is the current model for the BAP. This model would continue to served as a voluntary outreach approach, and meetings would hosted by KRCD, where representatives from each stakeholder group could get together to discuss and seek to resolve regional groundwater issues. At these meetings, agreements can be made if multiple groups would like to contribute to the development of regional projects outlined in this GWMP; however, the ultimate project-making authority would remain within the entity that is sponsoring the project. Financing would also be the responsibility of the sponsoring agency or group. The individual groups could also enter into to guide subsequent actions and provide funding. Advantages to this approach are as follows:

- Allows agencies to focus their resources on projects that are specific to their needs,
- No loss of control over management of individual groundwater resources, and

- Easiest to implement because it is a continuation of the current approach to groundwater management in the region.

Disadvantages to this approach are:

- More difficult to pursue regional projects that would benefit the entire Lower Kings Basin;
- Confusion over who coordinates projects and what role each agency plays during regional project planning, construction, operation, and maintenance;
- Inability to generate economies of scale for large projects;
- Projects that benefit only individual entities are less likely to receive state funding;
- Nothing to prevent individual stakeholders from undertaking actions that are not complementary to the BMOs; and
- No framework to resolve conflicts among individuals.

MUTUAL INTEREST–BASED MODEL

Under the mutual interest–based model, a group of stakeholders in the Lower Kings would form an institutional framework to undertake the specific GWMP projects. The stakeholders would enter into more formal arrangements such as 1) joint-power agreements (JPA), 2) coalitions, or 3) regional groundwater improvement districts. The new institution would have representation from each stakeholder in the region and would act as the governing body and funding mechanism for development of groundwater and conjunctive use projects in the region.

A MOU is a relatively informal agreement between individual public agencies to pursue a common purpose or goal. The organization formed does not have any formal power and it cannot undertake projects or enforce regulations. In effect, a MOU is basically a “gentlemen’s agreement” between all the agencies involved.

The JPA provides a formal contract among individual public agencies to jointly exercise the powers of each public agency. The JPA can be organized in any way the members wish. Most JPAs have a governing board made up of elected or appointed members of each participating entity. This can include funding authorities. The governing board sets the policy direction for the JPA and coordinates the means by which to enforce the policy.

The mutual interest–based approach would help ensure that GWMP actions are carried out and provide stable funding and institutional mechanisms for implementing projects. In the longer term, a set of regulations could be developed that would ensure local interest control and

manage the resources. For example, regional banking would require rules and regulations to protect local interests and maintain local control.

The institution or organization would be responsible for planning, construction, operation, and maintenance of projects outlined in the GWMP, and for establishing any operating rules or regulations designed to protect and preserve local authority. It could have the power to raise money for projects and could also employ its own staff to ensure that its objectives are met.

Advantages to this approach are:

- Ensures that the BMOs are met and that the regional benefits from following the BMOs are realized;
- Projects proposed by the governing body are much more likely to receive state funding; and
- Easier to resolve individual conflicts internally.

The obstacles that must be overcome to make this approach work are:

- Overcoming historical disputes between individuals, groups, or organizations in the region;
- Ensuring that every stakeholder has fair representation in the governing body. (For example, have each stakeholder's vote weighted by a factor of acreage, water use, population, monetary contribution, etc.);
- Ensuring that the institution formed is perceived as legitimate by both the locals and the state government;
- Obtaining funding for the institution;
- Ensuring that the institution does not threaten the development of individual projects as long as they still meet the regional BMOs;
- Ensuring that disadvantaged communities, special-interest groups, and new stakeholders have a means by which to be included and represented in the governing body; and
- Agreeing on regulations that must be easily understood and easy to enforce and on penalties if the regulations are not followed.

The BAP was not able to achieve a consensus on the approach due to limited time for further negotiation and for more consideration of the issues and opportunities. Section 6 contains further steps to continue to the dialog and develop a final approach to oversight, management and governance of the GWMP and development of capital facilities.

6.1 GWMP COMPONENTS

The GWMP components were built from the options identified and carried forward from the evaluation in Section 4. The GWMP components were specifically configured to meet local groundwater planning and management objectives presented in Section 3. The final components were also configured to conform to the BMOs. These GWMP components establish priorities for:

1. Development of Near- Term Local Recharge Projects;
2. Development of Long-Term Groundwater Recharge and Banking;
3. Stakeholder Involvement, Plan Oversight and Management;
4. Monitoring and Analysis Program;
 - a. Monitoring;
 - b. Development of Integrated Hydrologic Planning Tools; and
5. Groundwater Resource Protection.

The GWMP components are described along with the specific GWMP objective that are addressed by the component. Actions that are specific to the individual Areas are presented along with a listing of actions common to all of the Areas where this is appropriate. The responsible party is presented where this has been determined.

6.2 COMPONENT 1 - DEVELOPMENT OF NEAR TERM LOCAL RECHARGE PROJECTS

This component defines actions to meet the GWMP objectives defined in Section 3, including;

Objective 1: Identify and build near- term groundwater recharge projects within each Area to capture flood flows; begin to stabilize the basin; and to demonstrate the feasibility, benefits and cost effectiveness of recharge projects.

Objective 2: Establish rational and attainable Basin Management Objectives both regionally and for specific Areas to measure and track progress.

The near- term project options identified in Section 4 are carried forward for action and are integrated into this GWMP component. The Near- Term Local Recharge Projects provide an

integrated approach to addressing overdraft problems. These projects will help to reduce or avoid conflicts; provide multiple, regional benefits; protect the Lower Kings Basin during droughts; protect and improve water quality through recharging surface water; and improve local water supply security. The Lower Kings BAP will preserve local control of the groundwater basin through the active participation of the stakeholders in efforts to obtain funding and political support for the proposed projects. The integrated approach is needed to increase the probability of obtaining funding to implement the GWMP projects by demonstrating regional cooperation in physical solutions to overdraft.

KRCD and the BAP worked to identify potential projects that were ready to proceed and had minimal technical constraints. The BAP identified four local recharge projects that could be developed in the near term including the McMullin Recharge Ponds, the Raisin City Recharge Pond, Raisin City Recycled Water Program, and the North Fork Group Recharge Projects. The projects are recommended for inclusion in a joint Lower Basin Near- Term Groundwater Recharge Program so that they may be pursued as part of an integrated strategy to reduce overdraft.

PROJECT ACTIONS IN AREA A

The actions are intended to stabilize groundwater levels and implement near-term groundwater recharge projects. The stakeholders in Area A, with support and coordination of the BAP, will take the following actions.

1. The McMullin Group will promote, develop, and operate the McMullin Recharge Ponds with staff support provided by KRCD. The goal is to have the projects operational by 2010.
 - a. Complete the feasibility study.
 - b. Negotiate water agreement with KRWA.
 - c. Evaluate project benefits and costs.
 - d. Define local funding agreements and work with KRCD to obtain funding from state grants where available.
 - e. Obtain needed permits and environmental clearances.
 - f. Develop engineering plans, specification.
 - g. Develop project monitoring plan to document benefits.
 - h. Bid, construct and operate the project.

The feasibility study is nearing completion. Additional project costs are associated with permitting, design, construction, and engineering administration. The McMullin Recharge Ponds construction cost are estimated as \$1,063,800 for Site 1 (Phases 1 & 2) and \$ 1,039,800 for Site 2 based on the

original estimates that were made in 2000 (KRCD, 2000) and brought forward to current dollars for purposes of planning and budgeting. Final engineering, project permitting, and engineering administration is estimated (for purposes of preparing a planning level budget) at 10% of the capital costs, or \$210,000.

2. The Raisin City WD District will seek to develop the Raisin City Recharge Pond. KRCD will help to facilitate the dialog between Raisin City WD and FID. The Raising City WD will closely coordinate with the other Lower Kings Basin Interests through the BAP. The source of the water is flood water or purchased water to be wheeled through FID facilities to a canal to convey water to recharge ponds constructed on the land currently owned by the District. The goal is to have operational projects by 2010.
 - a. Promote and actively seek to develop the Raisin City Recharge Pond using existing District property. This will include close coordination with FID to existing FID facilities to convey water.
 - b. Negotiate any wheeling agreements with FID.
 - c. Complete the project design, develop final project costs.
 - d. Define local funding agreements, local assessments, and obtain approval from local land owners in the District.
 - e. Work with KRCD to obtain funding from state grants or low interest loans.
 - f. Obtain needed permits and environmental clearances.
 - g. Develop project monitoring plan to document benefits.
 - h. Bid, construct and operate the project.

The costs associated with Raisin City WD groundwater recharge project are estimated at \$3,350,000 (Provost and Prichard, April 2005). Engineering administration was estimated at 10% of the capital costs, or \$335,000 for purposes of budgeting and planning.

3. KRCD will help the Raisin City WD open a dialog and pursue development of a Raisin City Recycled Water Program, in cooperation with the City of Fresno and FID. The Raising City WD will also coordinate with the other Lower Kings Basin Interests through the BAP. The goal is to phase the recycled water program to expand the freshwater recharge project discussed above to include percolation and reuse of recycle water from the FRWTP by 2015.
 - a. Initiate a dialog with the City of Fresno, FID, and other stakeholders in the FRWTP to further develop support and agreements for “in-lieu” recycled water use and recharge projects that benefit all parties.
 - b. Raisin City WD will track the process to update the City of Fresno Water Master Plan and be an active stakeholder.
 - c. Seek to include the Raisin City recycled water program in the regional strategy for development and use of reclaimed wastewater.

- d. Begin an internal dialog to evaluate and resolve issues related to use of recycled water for irrigation and recharge.
- e. Initiate discussions with the RWQCB to resolve regulatory issues.

The Raisin City Recycled Water Projects project is estimated to cost between \$4,538,700 and \$23,734,000 to complete. These costs were based on prior estimates for the water recycling project (Provost and Prichard, 1995) but were brought forward to current dollars. The project is more complex and faces much more complex regulatory and institutional hurdles than the other near-term actions. For purposes of planning, it is assumed the entire project is to be developed in context of a regional recycled water program targeted at resolving regional overdraft issues and providing multiple benefits to the participants. Engineering administration costs for the largest of the project configurations are estimated at 10%, or \$2,370,000 for purposes of planning and budgeting.

- 4. KRCD will work with overlying land owners and water districts, including Raisin City WD, to promote the consideration of an improvement district for all of Area A for the following purposes;
 - a. Generating revenue dedicated to capital projects, achieving greater economies of scale and cost effectiveness, and to equitably distribute project benefits and costs.
 - b. Jointly fund planning, preliminary design, environmental compliance, and project development activities.
 - c. Purchase water for the Area.
 - d. Provide for local match funding requirements to state or federal programs to increase funding opportunities and recapture local tax dollars.
 - e. Build a project development capital reserve for project construction or land acquisition for development of recharge facilities.
 - f. Fund the proportional share of other basin management activities or common elements such as monitoring, data management, water conservation, or other programs.

PROJECT MANAGEMENT ACTIONS IN AREA B

Work within Area B will be coordinated through the North Fork Group. The North Fork Group will closely coordinate with the other Lower Kings Basin Interests through the BAP. The NFG will take the following actions by 2010.

- 1. Develop North Fork Group local recharge projects.
 - a. Obtain local and/or grant funding and complete North Fork Group groundwater recharge project feasibility investigations, and define local project priorities and costs.

- b. Evaluate hydraulic effects of put and take operational scenarios and recharge/discharge operations.
- c. Evaluate project benefits and costs.
- d. Negotiate cost sharing and management agreements for project construction within the NFG to complete the work and/or provide a local match for state or federal funds
- e. Initiate project design work upon completion of the feasibility study, develop engineering plans and specification.
- f. Obtain needed permits and environmental clearances.
- g. Develop project monitoring plan to document benefits.
- h. Construct and operate the project.

An AB 303 grant was submitted in 2004-2005 funding cycle to obtain support for a feasibility study and site characterization work. If the state funding is provided the project would be expedited. If a grant is not awarded local funds would be needed to keep the project moving forward, or the grant could be revised to address any issues and increase the competitiveness, and could be resubmitted in later funding cycles. Subsequent construction costs will be evaluated in detail once the feasibility work and preliminary engineering are complete, but a range of costs was estimated based on the cost of similar project an unit cost of other projects in the area. Using costs developed as part of the Raisin City WD Groundwater Recharge Project, in particular land acquisition cost of \$4,000 per acre, excavation to a depth of 3 feet, and excavation cost of \$2.50 cubic yard. The land acquisition and excavation costs to develop recharge ponds of 250 acres is approximately \$10,780,000. An additional 20% is added on to estimate the conveyance facility improvements for a total project cost were rounded to \$13,000,000. Engineering administration at 10% of the capital costs are estimated at \$1,300,000.

- 2. Document current operations through improved monitoring of deliveries, spreading and recharge project operations.
 - a. Develop a consolidated map of existing canal facilities. Inventory existing delivery and distribution infrastructure to identify constraints, needed improvements and operational requirements for conjunctive use.
 - b. Conduct a surface water study similar to the work conducted by KRCD for AID (KRCD, 1991) and CID (KRCD, 1993) to define opportunities to optimize system performance for conjunctive use.
 - c. Promote additional monitoring and measurements of canal operations to better document canal loses, water spreading benefits, and groundwater recharge from the canals.
 - d. Promote the restoration of canals to design capacities.
- 3. Consider development of an improvement district in Area B based on the North Fork Group members for the following purposes;

- a. Achieve greater economies of scale, cost effectiveness, and equitably distribute project benefits and costs.
- b. Jointly fund planning, preliminary design, environmental compliance, and project development activities.
- c. Purchase water for the Area.
- d. Provide for local match funding requirements to state or federal programs to increase funding opportunities and return state and federal taxes to the local community.
- e. Build a project development capital reserve for project construction or land acquisition
- f. Acquire land for recharge purposes or to fallow the land to reduce pumping in times of drought and conserve water. Develop and initiate land acquisition program.

MANAGEMENT ACTIONS IN AREA C

There were no major near term project actions identified by Area C stakeholders or determined necessary to stabilize groundwater levels. The Lower Kings BAP and KRCD staff will continue to work with interests in Area C to help monitor conditions, document problems, establish objectives and support projects. Near term actions include:

- 1. KRCD will develop a plan to work with local districts to operate canals to optimize retention in areas that are conducive to groundwater recharge. This includes working with local districts to identify project facilities and improvements that would allow for increased recharge.
- 2. Identify mitigation efforts for area growers that could be adversely impacted by recharge projects. This could include:
 - a. the construction of bentonite clay cut-off walls in areas that subject to high water levels during recharge operations;
 - b. purchase water level easements in areas that are subject to high water levels during recharge operations; and
 - c. outright purchase of lands subject to high water levels during recharge operations.

FUNDING FOR NEAR-TERM PROJECTS

- 1. Establish near 2005/2006 AB 303 grant project priorities for the Lower Kings Basin. Funding priorities need to be set the end of the August 05 to allow time to prepare applications to be submitted in early winter 05. KRCD will track grant timelines and keep the BAP informed.

2. Develop costs and priorities for a Lower Kings Basin capital facilities plan that could be considered for inclusion in the more regional Integrated Regional Water Management Plan (IRWMP). Such projects could become candidates for funding in context of Proposition 50, Chapter 8 Implementation Grant program. Project concepts must be ready to proceed to meet funding criteria and local resources would be needed for project planning and engineering. In addition, any projects to be funded must be part of an IRWMP.

The potential costs are summarized in Table 6.1 for purposes of planning and budgeting. Actual costs may vary depending final work plans and any firm construction bids or responses to proposals.

**Table 6.1. Summary of Estimated Costs for
Near-Term Lower Kings Basin Groundwater Recharge Projects**

Project	Size (ac)	Capital Cost (\$, millions)	Annual Cost (\$)		
			<i>Debt Service</i> ¹	<i>O & M</i> ²	<i>Total</i>
Raisin City – FID	80	3.350	222,600	17,700	240,300
Raisin City – WWTP	80	4.539	301,600	22,600	324,200
Raisin City – WWTP	960	23.734	1,577,400	118,300	1,695,700
McMullin (Site 1)	205	1.064	70,700	5,300	76,000
McMullin (Site 2)	15	1.040	69,100	5,200	74,300
North Fork Group ³	250	13.000	716,400	53,700	770,100
Lower Kings Basin Near-Term Total	1,590	46.727	2,957,800	222,800	3,180,600

1. Debt service was determined for 40 year payment schedule at 6% per annum
2. O&M was calculated as 7.5% per annum of capital costs
3. Land acquisition and excavation costs only

6.3 COMPONENT 2 - LONG-TERM GROUNDWATER RECHARGE AND BANKING

Objectives 3: Formulate long- term regional strategies to take advantage of groundwater storage space in the Lower Kings Basin.

Conjunctive use management options that were carried forward from Section 4 for further development into a long term GWMP components included;

- In-basin water transfers;
- Out-of-basin transfers;
- Out-of-basin flood flows;
- Regional recharge basins and spreading;
- Regional groundwater banking;

- Regional recycled water; and
- Regional conveyance systems.

To take advantage of the storage space in the Lower Kings Basin and begin to develop a strategy using the Opportunity Zone identified in the BMOs, these concepts should be further evaluated from both an engineering and institutional standpoint.

In contrast to all of the near-term individual projects that are relatively well defined and sponsored by local water districts, the long term GWMP components will require closer coordination and greater collaboration between all of the Lower Kings Basin stakeholders, and other interests outside of the planning area.

This GWMP Component is included to document progress in developing long-term, regional strategies to solve overdraft. The most important thing that the Lower Kings Basin can do to support local control is to further the current level of cooperation in the planning area and develop the institutional arrangements and management structures needed to promote a long-term solutions.

A first priority would be to achieve a consensus at the policy level between all of the interests in the Lower Kings Basin. To overcome institutional constraints, principles of agreement could be defined that provide a basis for discussion and negotiation surrounding any joint conjunctive use/groundwater banking project. During the GWMP development there was a general consensus that the priority of any regional groundwater banking project would be to;

- Reduce or eliminate overdraft of the underlying basin;
- Restore basin levels to a specified groundwater level;
- Supply the water needs of Lower Kings Basin; and
- Meet the needs of project partners.

The BMOs concepts was designed by the BAP to allow for consideration of long- term opportunities to recover the groundwater basin and help local Lower Kings Basin interests develop operating criteria, rules and thresholds that could be perfected in legal agreements and operating guidelines to manage the Opportunity Zone. Groundwater banking and operating criteria would be established and perfected in appropriate legal agreements between Lower Kings Basin interests and other potential participants. Institutional structures would also need to be put in place to regulate, monitor, and manage large-scale regional banking.

Developing the long-term options will likely require support and cooperation of outside interests, whether this support is through water transfers or exchanges, or in the form of financing. The interests outside the planning that could be participants in a more large scale venture include the other water districts and land owners overlying the Kings Groundwater

Subbasin, and/or those interests outside of the area entirely. Regional groundwater banking with outside partners has been discussed previously within the Kings Groundwater Subbasin, but no agreements have ever come to fruition due to cost, legal and political constraints. Agreements would need to insure that local costs would not be increased unreasonably, and any adverse impacts to local groundwater users would be need to be fully mitigated.

A regional banking option will face considerable challenges. However, it is a viable option for helping solve overdraft and providing benefits to the Lower Kings Basin, and the concepts should be further developed. Costs and schedules for the long-term program cannot be determined at this time. Evaluation of specific projects beyond the concepts carried forward is premature until such time as the management and institutional plan is developed, and greater level of involvement at a policy level is achieved. The next section discusses organizational and management in more detail.

6.4 COMPONENT 3 - STAKEHOLDER INVOLVEMENT, PLAN OVERSIGHT AND MANAGEMENT

The principals for GWMP implementation, roles and responsibilities, approaches to governance, plan oversight and organizational structure, and strategy to procure funding are discussed below. The GWMP related objectives from Section 3 that are to be met by this component are;

Objective 4: To maintain local control of the groundwater basin through development of agreements and institutional arrangements that promote the responsible management of groundwater resources by overlying cities, water districts, agencies, companies and landowners.

Objective 5: To continue to coordinate the Basin Advisory Panel to track progress, coordinate GWMP implementation.

Objective 6: To research and define financing strategies and program oversight to implement the GWMP projects and programs.

Not all of the issues regarding financing, governance, or management of the GWMP were fully resolved during development of the GWMP, and it is anticipated that there will be an ongoing dialog regarding how to fund, manage, govern and implement the program and obtain long term financing for capital projects.

PRINCIPLES FOR PLAN MANAGEMENT AND IMPLEMENTATION

The following principals for plan implementation are put forth for further discussion and development. KRCD Board, working with the other stakeholders in the Lower Kings Basin,

will need to take further action to establish policies and approaches for management and implementation of the GWMP. The concepts are put forth for further discussion are listed below.

1. Consensus on governance and funding will be sought through ongoing dialog and discussion of the BAP as the near-term GWMP Components are implemented.
2. BAP will work to set local funding priorities for competitive grants. The BAP should seek to set project priorities for local projects to avoid internal competition and ensure that Lower Kings GWMP requests are competitive with other areas and have a high probability of success.
3. Capital facility costs must be born by the entities that receive the benefit and benefits should be quantified and demonstrated through engineering and economic analysis before anyone is asked to pay or incur increased costs associated with long term financing.
4. Regarding governance, local control must be preserved, but it is generally recognized that there needs to be some type of institutional arrangements and a management structure within the Lower Kings Basin to implement the GWMP programs.
5. Local management requires finding local match funding for grants to conduct planning, project engineering, and for ongoing services that are requested by the BAP or any stakeholder group.
6. Project planning and non- structural program costs for such things as local match for grant funds, data collection, grant funding requests, and feasibility studies will be through KRCD as prioritized by the Board on an annual basis.
7. Regional projects must provide regional benefits and economies of scale must be documented. The funding mechanism for assuming debt for capital facilities has not been established.
8. No new agency is needed, instead, if contractual arrangements or agreements are needed, and this could be through JPA or other contractual agreements between existing parties to the plan to implement any of the action being considered.

SUPPORT AND COORDINATION

KRCD will provide staff support and coordination to the BAP, NFG, and McMullin group, and will also support the following actions or assume the following roles.

1. Serve as lead agency for GWMP implementation and update in the Lower Kings Basin.
2. Coordinate the BAP and area stakeholder groups and provide staff support.

3. Continue to collect groundwater data, manage the monitoring program, and prepare the annual groundwater report. The groundwater report will provide aggregated hydrographs to document progress towards meeting the BMOs.
4. Prepare an annual GWMP implementation plan status report to the KRCD Board and BAP to document GWMP related actions and progress in each of the areas.
5. Continue to track grant funding and loan opportunities to meet GWMP objectives in the Lower Kings Basin and notify the KRCD Board and BAP as to the probability, cost, and work plan to seek and obtain support.
6. Provide grant writing, technical support and project management services to the stakeholder groups for projects within each of the Areas.
7. Utilize existing KRCD community affairs programs to report on GWMP progress as it occurs, describe problems, present opportunities, and gain political support for the program.
8. Seek to expand participation in the Area stakeholder groups (McMullin, NFG) by actively working with land owners and water agencies to broaden the awareness and participation.
9. Track staff and other direct costs for services provided to the Lower Kings Basin.

GOVERNANCE, PLAN OVERSIGHT AND ORGANIZATIONAL STRUCTURE

Appropriate institutional structures are needed to manage the basin, develop and fund projects, and coordinate to protect local interests. Plan oversight and organizational principals for GWMP implementation are presented below to further discussions on how to best manage local groundwater supplies.

1. The KRCD Board will continue to direct and prioritize KRCD staff involvement in the Lower Kings Basin GWMP implementation.
2. The KRCD Division 4 and 5 representatives should serve as Chair and Vice Chair for the Lower Kings Basin Advisory Panel to ensure that there is continuity and a high level of policy support for further development of conjunctive use and implement of the GWMP.
3. The McMullin Group will be the stakeholder group for coordinating outreach, programs and project priorities within Area B, with emphasis on implementing the near term projects.
4. The North Fork Group will be the stakeholder group for coordinating outreach, programs and project priorities within Area B, with emphasis on implementing the near term projects.
5. BAP participation should be voluntary and open to all property owners or stakeholders with a vested interest in the Lower Kings Basin.
6. The BAP should continue to meet to;

- a. Serve as the vehicle for Lower Kings Basin stakeholder involvement, promote the GWMP, provide a forum for discussion;
- b. Coordinate Lower Kings Basin involvement in regional water planning efforts and track programs with potential affects to the Lower Basin interests, including the work associated with the Upper Kings Water Forum;
- c. Hold regulator meetings, at least semi-annually, to review progress towards meeting the BMOs, coordinate actions in the Lower Kings Basin, and to distribute information and results in each of the Areas;
- d. Distribute information on regional water issues and projects that could affect Lower Kings Basin interests;
- e. Identify and provide Lower Kings Basin representatives to regional efforts or programs;
- f. Resolve conflicts internally;
- g. Develop agreements and local funding strategies and sources for ongoing programs, KRCD staff support, or shared engineering services;
- h. Discuss regional projects and define preferred project alternatives that should move forward
- i. Coordinate formation of a Joint Powers Authority or more formalized mechanism to developed and finance regional projects.

FUNDS AND FUNDING

- 1. One time costs for feasibility studies, project engineering, environmental compliance or other needs associated with the near term local projects priorities contained in the GWMP plan or its subsequent updates, will be negotiated and money provided within each of the Areas.
- 2. Grant funding opportunities will be identified and grants sought whenever possible for the priority studies needed to support GWMP Near-Term Component (local projects).
- 3. Long term debt financing for GWMP Near-Term Component (local projects) will also be negotiated and subject to agreements within each of the individual Areas and participants in the project.
- 4. Funding for large regional projects anticipated as part of the Long- Term GWMP component would be the basis for formation of a JPA, new district, or other contractual mechanisms and agreements to support, planning, engineering, and environmental compliance, local match share contribution to any grant or loan, and for obtaining long term financing of any debt.
- 5. The BAP should continue to evaluate long-term, stable funding for ongoing programs (e.g.; project planning, engineering services, monitoring, reporting,

staff support to the BAP), and to further investigate capital requirements as the long term, regional projects are evaluated.

CONFLICT RESOLUTION

The BAP has served as the Lower Basin planning body and a forum for member agencies and land owners to share their groundwater management plan issues and expectations. It is anticipated that this group can grow and continue the management efforts, build awareness and political support, and ensure that the GWMP implementation does not detrimentally affect other local stakeholders. In order to avoid serious disputes the following points on conflict resolution are made.

1. Litigation over groundwater should be avoided and used only as a last resort. Mediation services should be attempted prior to litigation when ever possible.
2. Expand the membership to ensure all parties in the Lower Kings Basin are informed regarding the GWMP program. Create awareness through outreach and expanded community affairs efforts to promote the GWMP. Identify the BAP as the opportunity for input and to resolve or prevent disputes.
3. Lower Kings Basin representatives should seek to be actively engaged and track other regional planning efforts such as the Upper Kings Integrated Regional Water Management Plan to ensure that their voice is heard, interests are protected, and avoid surprises. Other contemporary efforts with regional implications are related to the City of Fresno Water Master Plan and Upper Kings Water Forum.
4. Attempts to resolve conflicts internal to the Lower Kings Basin should through consensus and dialog within the Areas, and between water management agencies and land owners within each of the Areas.
5. Conflicts within the Lower Basin should seek to involve the BAP and KRCD Board members for Regions 4 and 5. Conflict between the Lower Kings Basin and any other interests within the region should seek to be resolved through the KRCD and KRWa Boards.

6.5 COMPONENT 4 - MONITORING AND ANALYSIS PROGRAM

Objective 7: Implement monitoring programs that increase the understanding of Lower Kings Basin operations, track progress towards meeting goals, and evaluate and forecast conditions.

The monitoring and technical support component of the GWMP needs to be able to assess the current condition of the Lower Kings Basin, forecast future conditions, and tracking the basin response to management actions. Monitoring is needed to document that the anticipated benefits of a project are actually being delivered, and that any impacts that were anticipated are being avoided. The Lower Kings Basin monitoring program includes provisions for

groundwater level and quality, land surface elevation or land subsidence, and surface water and groundwater interaction. Protocols for collection of data are an important part of the data collection effort. In addition, further technical support and analysis are recommended to development of a model of the groundwater basin. The GWMP Component 4 covering the monitoring and technical support program will include the following elements;

- Groundwater Level Monitoring;
- Groundwater Quality Monitoring;
- Land Surface Elevation Monitoring;
- Protocols For Collection of Groundwater Data;
- Monitoring Surface Water-Groundwater Interaction;
- Development of Kings Basin Groundwater Data Center; and
- Development of a Regional Integrated Hydrologic Model.

Groundwater level data from wells in the Lower Kings Basin has been collected from before 1950 to present. This data was collected by DWR, KRCD, and Lower Kings Basin water agencies. The number of wells in the networks have varied over time as wells were deleted and added. As such, the Lower Kings BAP is considering a standardized network of groundwater wells that combines the wells that are monitored by DWR, KRCD, and Lower Kings water agencies. The evaluation of the monitoring well network will cost approximately \$75,000 and should be considered for grant funding.

Actions

The following actions will be taken by in the Lower Kings Basin:

1. KRCD will coordinate with DWR and Lower Basin water agencies to identify wells to be included in a long-term monitoring network.
2. Coordinate with DWR, KRCD, and Lower Basin water agencies to undertake a network evaluation.

GROUNDWATER QUALITY MONITORING

Most of the wells in the Lower Kings Basin are used for agricultural purposes. These wells have been monitored by the well operators to ensure crop productivity. These monitoring records are typically kept private and are not public information. Water quality monitoring of drinking water sources has been performed by municipalities in the Lower Kings Basin as required by DHS under Title 22. Sources of water quality data include DWR, KRCD, Lower Kings Basin member water agencies and local growers, USGS, and Local municipalities.

The BAP determined that the current level of water quality monitoring is sufficient to support the existing land use and beneficial uses of the Lower Kings Basin. It may be important to have a network of dedicated monitoring wells to track regional trends and to serve as a warning system for changes in water quality.

Actions

1. KRCD will track the Groundwater Ambient Monitoring and Assessment (GAMA) that the state is implementing with support from the USGS. This program is scheduled to begin in January 2006.
2. KRCD will evaluate the development of a groundwater quality network of wells as part of the efforts to evaluate the overall monitoring program and network.
3. Collect privately maintained water quality data from willing providers for purposes of project feasibility analysis. Confidentiality of original data must be maintained.
4. Coordinate with member agencies so that uniform monitoring protocols are used.
5. Identify potential wells that USGS could incorporate into NAWQA well network and determine timing and frequency of monitoring.
6. Promote the creation of groundwater quality monitoring well network.

LAND SURFACE ELEVATION MONITORING

Land subsidence can result from compaction of underlying formations that are affected by water level decline. Land subsidence is well documented in Areas west of the Lower Kings Basin. Land subsidence is a result of elastic and inelastic compression in the underlying basin. Elastic subsidence results from the reduction of pore fluid pressures in the aquifer and typically rebounds when pumping stops. Inelastic subsidence occurs when pore fluid pressures decline to a point where sediments collapse and results in permanent compaction. The extent of land subsidence in the Lower Kings Basin has been minimal and as such, land subsidence is not actively monitored in the Lower Kings Basin.

Actions

The Lower Kings Basin, through support provided by KRCD, will undertake the following actions.

1. Promote the surveying of selected wells in the western portion of Lower Kings Basin.

2. Coordinate with Lower Kings Basin stakeholders to determine if there are suitable benchmark locations to assist in determining and measuring land subsidence.
3. Educate Lower Kings Basin water agency members of the potential for land subsidence and signs that could be indicators of subsidence.
4. Contact USGS and DWR for potential partnering opportunities for extensometer installation and monitoring.

PROTOCOLS FOR COLLECTION OF GROUNDWATER DATA

KRCD, DWR, and several Lower Kings Basin water agencies collect groundwater data. There is probably a significant range of techniques, frequency of measurements, and documentation methods for the collection of groundwater level and quality by the aforementioned agencies. The lack of consistency between the agencies may provide an incomplete vision of basin-wide groundwater conditions.

Actions

The Lower Kings BAP, with support of KRCD will improve the utility of collected groundwater data by implementing the following:

1. Develop standard procedures for collection of groundwater level and quality data.
2. Provide training regarding standard procedures.

MONITORING SURFACE WATER-GROUNDWATER INTERACTION

The interaction between groundwater and surface water has not been extensively evaluated in the Lower Kings Basin. Lower Kings Basin member agencies and KRWA measure streamflow at weirs and head gates. The difference in flow between successive weirs is approximately the gain from or loss to groundwater. These measurements of gain or loss are approximations and have not examined closely.

Actions

The Lower Kings BAP will pursue actions that increase the knowledge regarding the relationship between surface water and groundwater in the Lower Kings Basin:

1. Compile data regarding unmeasured riparian diverters and develop estimates of diversion amounts.

2. Correlate groundwater levels from wells in the vicinity of the Kings River and stream flow data to study the hydraulic connection between the river and the groundwater system.
3. Coordinate and develop relationships with local, state, and federal agencies to investigate the interaction of the Kings River with the groundwater system.
4. Develop the data necessary to improve the evaluation of groundwater and surface water interaction.

SUPPORT DEVELOPMENT OF KINGS BASIN GROUNDWATER DATA CENTER

The efficiency of the process by which KRCD obtains groundwater level and water resources data can be improved and standardized by developing a data management system for groundwater and water resources data. A Kings Basin Groundwater Data Center (GDC) should be developed by KRCD to support the capture, processing, storage, retrieval and reporting of groundwater data. The estimated range of costs of developing a GDC is \$50,000 to \$100,000 and should be considered a candidate for grant funding.

Actions

The Lower Kings BAP will support KRCD in developing a database to track and manage groundwater level data. It is recommended that the KRCD Board establish a priority to support development of a GDC.

1. Finalize the business needs and requirements of a GDC and investigate opportunities to share and publish the data in web accessible formats.
2. Ensure the proposed system is compatible with existing technology and the KRCD information systems policies and/or strategic plan.
3. Develop alternatives including costs for initial set up, ongoing maintenance, and training and prepare a final recommendation.
4. Develop and test a prototype that would expedite the annual report production and publication.
5. Develop and install the system and provide staff with the appropriate training and documentation.
6. Compile historical data, conduct quality control, and upload data into the system.
7. Correlate groundwater levels from wells in the vicinity of the Kings River and stream flow data to study the hydraulic connection between the river and the groundwater system.

8. Coordinate and develop relationships with local, state, and federal agencies to ensure that data can be electronically exchanged to save money and improve data quality.

SUPPORT DEVELOPMENT OF A REGIONAL INTEGRATED HYDROLOGIC MODEL

Currently DWR and KRCD are in the initial planning steps of developing a regional integrated hydrologic model for the area overlying the Kings River groundwater basin, as identified in the DWR Bulletin 118, and the closely related areas based on hydrology, hydrogeology and water supply facilities. This model area will include all of the Lower Kings Basin as well as the Upper Kings Basin (AID, FID, and CID). The detailed extent of the model boundaries have not yet been determined and would be established after further review of the data, aquifers, geology and input from the technical analysis work group. The development of this model is to be funded by DWR, KRCD, and other Upper Kings Basin Stakeholders. Lower Kings Basin has not been requested to support this model at this time, with the exception of Raisin City WD who has chosen to help fund model development.

The purpose of the Kings Basin model is to support planning and decision making, to create a shared understanding of how the Kings Basin operates, and to reduce the uncertainty when selecting between alternative solutions. Using analysis of the model's result, water planners in the lower Kings Basin can make better decisions about public and private investments in conjunctive use water projects. Some of the anticipated benefits of an integrated model include:

- Developing a shared database with aggregated data from a wide range of sources and formats;
- Evaluating and reviewing historical data and making explicit decisions on data quality and usefulness;
- Improving the understanding of basin operations and water budget;
- Creating a shared consensus on water supply and overdraft problems;
- Testing a wide range of planning assumptions;
- Comparing alternatives and analyzing a wide range of "what-if" scenarios;
- Helping answer Kings Basin-specific questions on technical and policy issues;
- Supporting economic and environmental analysis and comparing impacts and benefits; and
- Improving the defensibility and technical credibility of the analysis results.

Information from the stakeholders in the Lower Kings Basin will be necessary to aid in the model development. Model development is a very data-intensive process and requires many time series and physical characteristics data. Local engineers, scientists, and stakeholders from

member districts will be needed to assist in data collection, to review of model input data and results, and to share their local knowledge with KRCD and DWR as the model is developed.

Actions

The Lower Kings BAP will pursue actions that increase the knowledge regarding model development and analysis of the relationship between surface water and groundwater in the Lower Kings Basin:

1. Support the compilation data and development of the model.
2. Support the model development by using existing staff or engineering support contractors to exchange data and review model calibration results.
3. Make existing water delivery and operations data available to the development team.

6.6 COMPONENT 5 - COMMON ELEMENTS FOR GROUNDWATER RESOURCE PROTECTION

The Lower Kings BAP considers groundwater resource protection a critical component for ensuring recovery of the basin and improving its sustainability. Groundwater resource protection includes basin recovery and sustainability, and prevention of contamination. Prevention measures include well construction, abandonment, and destruction, wellhead protection, and control of contaminated and saline groundwater.

WELL CONSTRUCTION POLICES

Currently, Fresno County regulates well construction policies for wells in management Area A and Area B. The Kings County Public Works Department regulates well construction policies for wells in management Area C. Only persons who possess an active C-57 Water Well Contractors License may perform construction work on wells. The California Well Standards Ordinance requires that all abandoned wells must be destroyed. Wells that are improperly abandoned could lead to the contamination of the groundwater, and inter-aquifer mixing. Following the rules and regulations explained in DWR bulletins 74-81 and 74-90, Fresno County Department of Community, Environmental Health System and Kings County Public Works Department are responsible for administration and enforcement of a well abandonment and destruction program for the management Area A and Area B, and for the management Area C, respectively.

Actions

The Lower Kings BAP will do the following:

1. Ensure that member agencies and Lower Kings Basin growers have access to county well construction ordinances and understand proper well construction procedures.
2. Coordinate with Lower King Basin water agencies to provide guidance on well construction.
3. Provide data to support revision to well standards should agricultural beneficial uses or urban uses be impaired due to groundwater contamination or should changes in standards become needed.
4. Ensure that member agencies and Lower Kings Basin growers have access to county well abandonment and destruction ordinances and understand proper well abandonment and destruction procedures.
5. Coordinate with Lower Kings member agencies on the reporting of abandoned and destroyed wells to confirm that information has been collected by DWR.
6. Coordinate with Lower King Basin water agencies to provide guidance on well abandonment and destruction.

PROTECTION OF RECHARGE AREAS

The surficial geology of the Lower Kings Basin has been evaluated to determine the areas with high recharge potential. These areas are important in the development of recharge projects in the lower basin. These areas are primarily used for agricultural purposes and could be at risk for contamination.

Actions

The Lower Kings BAP will do the following:

1. Further delineate areas with high recharge potential.
2. Identify growers that overlie areas with high recharge potential.
3. Work with those growers to protect recharge areas through voluntary water conservation and nutrient management programs.

CONTROL OF THE MIGRATION OF CONTAMINATED GROUNDWATER

The migration of contaminated groundwater is secondary concern for the Lower Kings BAP. Contaminated groundwater plumes are relatively small and localized in the Lower Kings Basin. Regulatory agencies such as the State Water Resources Control Board or Environmental

Protection Agency are responsible for the regulation of the migration of contaminated groundwater. KRCD's role is to cooperate with the regulatory agencies to aid in maintaining the best practical quality water supply for the management Area A, Area B, and Area C.

Actions

The Lower Kings BAP will do the following:

1. Promote the development of a monitoring well network to serve as an early warning system for public water supply wells.
2. Provide information to all Lower Kings BAP member agencies and companies regarding the location of contaminant plumes and Leaking Underground Storage Tank (LUST) locations.

MONITORING OF SALINE WATER INTRUSION

Overall, there are no known occurrences of saline water intrusion within the management Area A, Area B, and Area C. Saline water intrusion from the west side of the San Joaquin Valley (particularly from Westlands WD) is a concern for Lower Kings BAP. Although currently not a problem, there are hydraulic conditions (e.g., depressed groundwater levels) present that would allow saline water intrusion to occur in the future. In addition, a shallow perched saline water table exists mainly in the southern portion of management Area C. However, this is not considered to be saline water intrusion.

With the establishment of a monitoring program, any saline water intrusion can be identified. If an intrusion is identified, then at that time a plan can be developed to deal with the problem.

Actions

The Lower Kings BAP will do the following:

1. Track the progression of saline water moving from west through the biennial monitoring of TDS.
2. Coordinate with BAP member agencies the evaluation of saline water intrusion.

- Bertoldi, G. L., R. H. Johnson, and K. D. Evenson. 1991. *Groundwater in the Central Valley California—A Summary Report*. US Geological Survey Professional Paper 1401-A.
- California Data Exchange Center (CDEC) accessed December 2004 at <http://cdec.water.ca.gov>.
- California Water Code, Section 10750, *Groundwater Management*.
- CH2M Hill, 1992. *Fresno/Clovis Metropolitan Water Resources Management Plan, Phase II Report, Water Supply Alternative*. May 1992.
- CVRWQCB, 2003. Central Valley Regional Water Quality Control Board, 2003. 2002 CWA Section 303(d) List of Water Quality Limited Segment. Accessed online on 1/3/2005 at <http://www.swrcb.ca.gov/tmdl/docs/2002reg5303dlist.pdf>.
- CVRWQCB, 2004. Central Valley Regional Water Quality Control Board. *Water Quality Control Plan for the Tulare Lake Basin (Basin Plan)*. Last revised January 2004.
- DHS, 2001. California Department of Health Services, 2001. *California Health Laws Related to Recycled Water*.
- DHS, 2004. *DWSAP Source Water Assessments*. Accessed online at <http://swap.ice.ucdavis.edu/TSinfo/TSsearch.asp> on 12/30/2004).
- DWR, 2004. *The California Water Plan Volume 2 – Resource Management Strategies Advisory Committee Review Draft*. http://www.waterplan.water.ca.gov/b160/B160.Draft.June.7.2004/Vol_2/watertrans.pdf
- Fresno, City of. *About Wastewater Management*. Accessed 3/30/2005 online at http://www.fresno.gov/public_utilities/wastewater/ww_about.asp
- Fresno, County of, 2000. *Fresno County General Plan Policy Document*, October 3, 2000.
- Hanak, 2003. *California Water Market, by the Numbers*. Public Policy Institute. Prepared for DWR, October 2003.
- Ireland, R.L., et al. 1984. *Land Subsidence in the San Joaquin Valley, as of 1980*. USGS Professional Paper 437-1.
- Kings County Planning Agency. *Personal Communication with Greg Gatzka*. January 2005

- KRCD, 1991. *Alta Irrigation District Surface Water Study*. Kings River Conservation District. December 1991.
- KRCD, 1993. *Consolidated Irrigation District Surface Water Study*. Kings River Conservation District. June 1993.
- KRCD, 1995. *Groundwater Management Plan for Kings River Conservation District Area A*. March 1995. Adopted April 1995.
- KRCD, 1996. *Groundwater Management Plan for Kings River Conservation District Area B*. February 1996. Adopted March 1996.
- KRCD, 1998. *Groundwater Management Plan for Kings River Conservation District Area C*. June 1998. Adopted August 1998.
- KRCD, 1999. *Artificial Recharge in the Kings River Service Area*. Kings River Conservation District, 1999.
- KRCD, 2000. *Feasibility Study Report. Preliminary Design and Estimate of Costs for Two Potential Groundwater Recharge Sites Within the McMullin Recharge Project Area*. Kings River Conservation District, April 2000.
- KRCD, 2004. *Unpublished City Limit Data*. December 2004.
- KRCD, 2005. *Unpublished data regarding Kings River streamflow below Lower Kings Basin Weirs*.
- KRWA, 2005. *Unpublished Kings River Flow Data Measured Below Weirs Data*. February 2005.
- Kings County, 2004. *Kings County General Plan*, as updated and amended January 2004.
- Provost and Pritchard, 1995. *Feasibility of Utilizing the City of Fresno's Wastewater for Raisin City Water District*.
- Provost and Pritchard, 2005. *Unpublished Canal Characteristic Data*. February 2005.
- Recycled Water Task Force, 2003. *Water Recycling 2030*. June 2003.
- SWRCB, 2001. *Strategic Plan*. Accessed 3/30/2005 online at <http://www.waterboards.ca.gov/strategicplan/index.html>
- SWRCB, 2002. *Water Transfer Issues in California, Final Report to the California State Water Resources Control Board by the Water Transfer Workgroup*. June 2002

SWRCB, 2004. *Water Recycling Funding Program Guidelines*. Accessed 3/30/2005 online at http://www.waterboards.ca.gov/recycling/docs/finalwrcpguidelines_oct2004.pdf

USGS, 2004. Data accessed on- line at:

http://ca.water.usgs.gov/sanj/data_sw/bedsed1.s2501.html;

http://ca.water.usgs.gov/sanj/data_sw/bedsed2.s2501.html;

http://ca.water.usgs.gov/sanj/data_sw/tissue1.s2101.html and

http://ca.water.usgs.gov/sanj/data_sw/tissue2.s2101.html.

WRIME, 2003a. *Basin Assessment Report for the Upper Kings Basin*. Prepared for the Upper Kings Basin ISI Participants in Coordination with The California Department of Water Resources.

WRIME, 2003b. *Preliminary Conjunctive Use Assessment Report*. Prepared for the Upper Kings Basin ISI Participants in Coordination with The California Department of Water Resources.

BEFORE THE BOARD OF DIRECTORS
OF THE KINGS RIVER CONSERVATION DISTRICT
FRESNO, CALIFORNIA

RESOLUTION NO. 03-02

AUTHORIZING THE PREPARATION AND EXECUTION OF DOCUMENTS WITH THE
CALIFORNIA DEPARTMENT OF WATER RESOURCES.

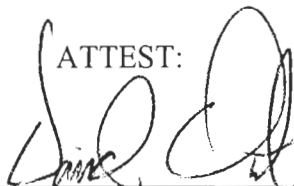
BE IT RESOLVED by the Board of Directors of the Kings River Conservation District that application be made by this District to the California Department of Water Resources to obtain a Local Groundwater Assistance grant pursuant to the Local Groundwater Management Assistance Act of 2000 (Water Code Section 10795 *et seq.*), and to enter into an agreement to receive a grant for the development of the Kings Basin Coordinated Groundwater Management Plan, the General Manager of the District is hereby authorized and directed to prepare the necessary data, make investigations, execute and file such application and execute an agreement with California Department of Water Resources to accept the grant.

THE FOREGOING RESOLUTION was passed and adopted by the Board of Directors of the Kings River Conservation District at its regular meeting this 12th day of November 2002, by the following vote:

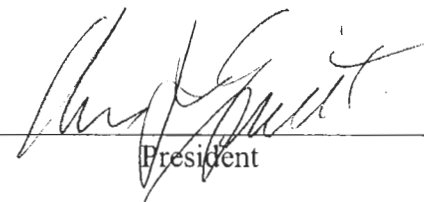
AYES: Director Quist, Howe, Johns, McKean, Waldner,
White, Yoshimoto

NOES: None

ABSENT: None

ATTEST:


Secretary

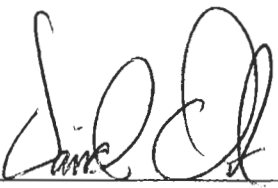


President

SECRETARY'S CERTIFICATE

I, David L. Orth, Secretary of Kings River Conservation District, hereby certify that the foregoing is a full, true and correct copy of a resolution duly adopted at a regular meeting of the Board of Directors of said District duly and regularly held at the regular meeting place thereof on the 12th day of November, 2002, of which meeting all of the members of said Board of Directors had due notice and at which a majority thereof were present.

WITNESS my hand and the seal of Kings River Conservation District this 12th day of November, 2002.



Secretary

(Seal)

BEFORE THE BOARD OF DIRECTORS OF THE
Kings River Conservation District

RESOLUTION -__

RESOLUTION OF INTENT TO ADOPT
THE LOWER KINGS RIVER BASIN GROUNDWATER MANAGEMENT PLAN

WHEREAS, in 1992, the State Legislature enacted Assembly Bill 3030, declaring groundwater to be a valuable natural resource, and encouraging local agencies to work cooperatively to manage groundwater resources and to adopt and implement groundwater management plans.

WHEREAS, in 2002, the State Legislature also enacted Senate Bill 1938 which further encourages local agencies to coordinate the development and implementation of groundwater management plans.

WHEREAS, the Kings River Conservation District Board of Directors supports local management and control of local groundwater.

WHEREAS, the Kings River Conservation District (KRCD) has been the local agency for supporting the development of the Lower Kings Basin Groundwater Management Plan (GWMP), and has worked with numerous public and private entities through the Lower Kings Basin Advisory Panel (BAP).

WHEREAS, land owners, water agencies, and stakeholders within the Lower Kings Basin share a common groundwater basin and have participated in the Lower Kings Basin Advisory Panel (BAP) to provide input to the Lower Kings Basin GWMP and anticipate seeking funding for groundwater projects from the state.

WHEREAS, the Board of Directors of the Kings River Conservation District, with the advise and input of the BAP has defined the Lower Kings Basin planning area (Figure 1.1), located in all of, or portions of KRCD Divisions 4 and 5, and within the Kings River Groundwater Basin as identified in the California Department of Water Resources Bulletin 118-10; and has further identified specific GWMP Areas A, B, and C (Figure 1.2) which also include the water districts and ditch companies in the region (Figure 1.3); and,

WHEREAS, the Lower Kings Basin GWMP contains components as required by the California Water Code Sections (Sections 10753.7), which include:

1. Basin Management Objectives (BMOs);
2. Monitoring and management of groundwater levels;
3. Groundwater quality degradation;
4. Inelastic land surface subsidence;
5. Changes in surface flow and surface water quality that directly effect groundwater levels or quality or are caused by groundwater pumping in the basin;
6. Local agency plan to involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin; and,

Draft KRCD Resolution to Adopt Lower Kings Basin GWMP

7. A map showing the California Department of Water Resources designated groundwater basin (Bulletin 118), also showing the area of the local agency subject to the plan, and boundaries of other local agencies that overlie the basin to be included in the groundwater management plan.

WHEREAS, the GWMP also evaluates voluntary components relating to all of the following areas (CWC 10753.8):

- a) The control of saline water intrusion.
- b) Identification and management of wellhead protection areas and recharge areas.
- c) Regulation of the migration of contaminated groundwater.
- d) The administration of a well abandonment and well destruction program.
- e) Mitigation of conditions of overdraft.
- f) Replenishment of groundwater extracted by water producers.
- g) Monitoring of groundwater levels and storage.
- h) Facilitating conjunctive use operations.
- i) Identification of well construction policies.
- j) The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
- k) The development of relationships with state and federal regulatory agencies.
- l) The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

WHEREAS, nothing in the state law (CWC 10753.9) shall be construed as authorizing the Kings River Conservation District to make any binding determination of the water rights of any person or entity, and nothing in the state law (CWC 10753.1), or in the Lower Kings Basin GWMP adopted pursuant to this part, affects surface water rights or the procedures under common law or local groundwater authority, or any provision of law other than this part that determines or grants surface water rights.

WHEREAS, state law does not allow an agency to obtain certain funds without being covered by or in a GWMP that meets state requirements.

WHEREAS, coverage by the GWMP is voluntary and only to be provided to those agencies and organizations in the Lower Kings Basin that officially seek coverage by Resolution of the Board or decision making authority, with could include the city council or Board of Supervisors if the incorporated cities or county, respectively, that are included in the Lower Kings Basin Areas A, B, and C.

NOW, THEREFORE, BE IT RESOLVED as follows:

1. This KRCD Board of Directors, acting as the local agency, hereby accepts the draft Lower Kings Basin GWMP.
2. It is the Board of Director's intent that the public and agencies in the Lower Kings Basin be provided time for review, comment and input on the Lower Kings Basin GWMP prior to the adoption of the GWMP by the Board of Directors.
3. The Board will consider the input of other public or private agencies overlying in the Lower Kings Basin or affected by GWMP at a regularly scheduled public hearing no

Draft KRCD Resolution to Adopt Lower Kings Basin GWMP

later than 60 days from the date of approval of this Resolution in order to receive comment and consider adopting the plan.

4. Prior to adopting the GWMP, this Board of Directors shall further notice the hearing to receive public comment and to determine whether to adopt the Plan. Landowners may file written protests to the adoption of the Lower Kings GWMP, and if the written protests represent more than fifty percent of the assessed value of the land within the District subject to groundwater management, the Plan shall not be adopted and the District shall not consider adopting a plan for that area for a period of one year after the Hearing.
5. Following adoption of the Lower Kings Basin GWMP by the KRCD Board of Directors, each of the management entities within the area, as represented by the local water district or ditch company, shall not be covered until coverage under the GWMP is approved by resolution of the appropriate decision making body, and the resolution is provided to KRCD and filed with the Lower Kings Basin GWMP.

PASSED AND ADOPTED _____, by the following vote of the Board of Directors, to wit:

AYES:

NOES:

ABSENT:

XXXXX, Chairman
Board of Directors of the
Kings River Conservation District

ATTEST: XXXXXX
Secretary of the Kings River Conservation District

C.1 LAND AND WATER USE

This appendix documents the land and water use analyses conducted as part of the development of the Groundwater Management Plan for the Lower Kings Basin. Current and future land use patterns in the Lower Kings Basin were analyzed using GIS. Land use is a direct determinant of water use. Land use mapping of the current and future land use allows for estimates of the current and projected water demand.

CURRENT LAND AND WATER USE

Water demand can be estimated by the unit water demand associated with a particular land use type. Unit water demand or annual water duty is defined as the amount of water used per acre per year. Table C.1 presents water duties used in estimating water demand as part of this analysis (KRCD, 1993). These water duties are based on applied water requirements.

The current (1999-2000) land use in the Lower Kings Basin is shown in Figure C.1. As shown in Figure C.1, agriculture is the predominant land use in the study area. Urban areas are the cities of San Joaquin (A1), Riverdale (B1), Lemoore (C), Raisin City (A), Lanare (B1), Laton (B1), and Tranquility (A1). The acreages and water demand for each WMA and land use type is shown in Table C.1.

The data shown in Figure C.1 was obtained from DWR, and is based on land use surveys conducted for Fresno County in 2000, Tulare County in 1999, and Kings County in 2003. The land use summary included in Table C.2 are based on a GIS analysis of the most current land use. Most of the study area is located within Fresno and Kings Counties, thus the estimates of land use acreage are representative of the 1999/2000 land use conditions.

PROJECTED LAND AND WATER USE

Land use is expected to convert from agricultural uses to urban uses near or adjacent to existing cities and towns over the next 20 to 30 years. In addition, it is expected that cropping patterns/crop mix will change over the next 20 to 30 years and that undeveloped area will be developed for urban use.

Figure C.2 shows the projected land use for the year 2030. Projected land use was based on information obtained from local land use planning agencies (i.e., Fresno County Local Agency

Table C.1. Current Land Use Summary

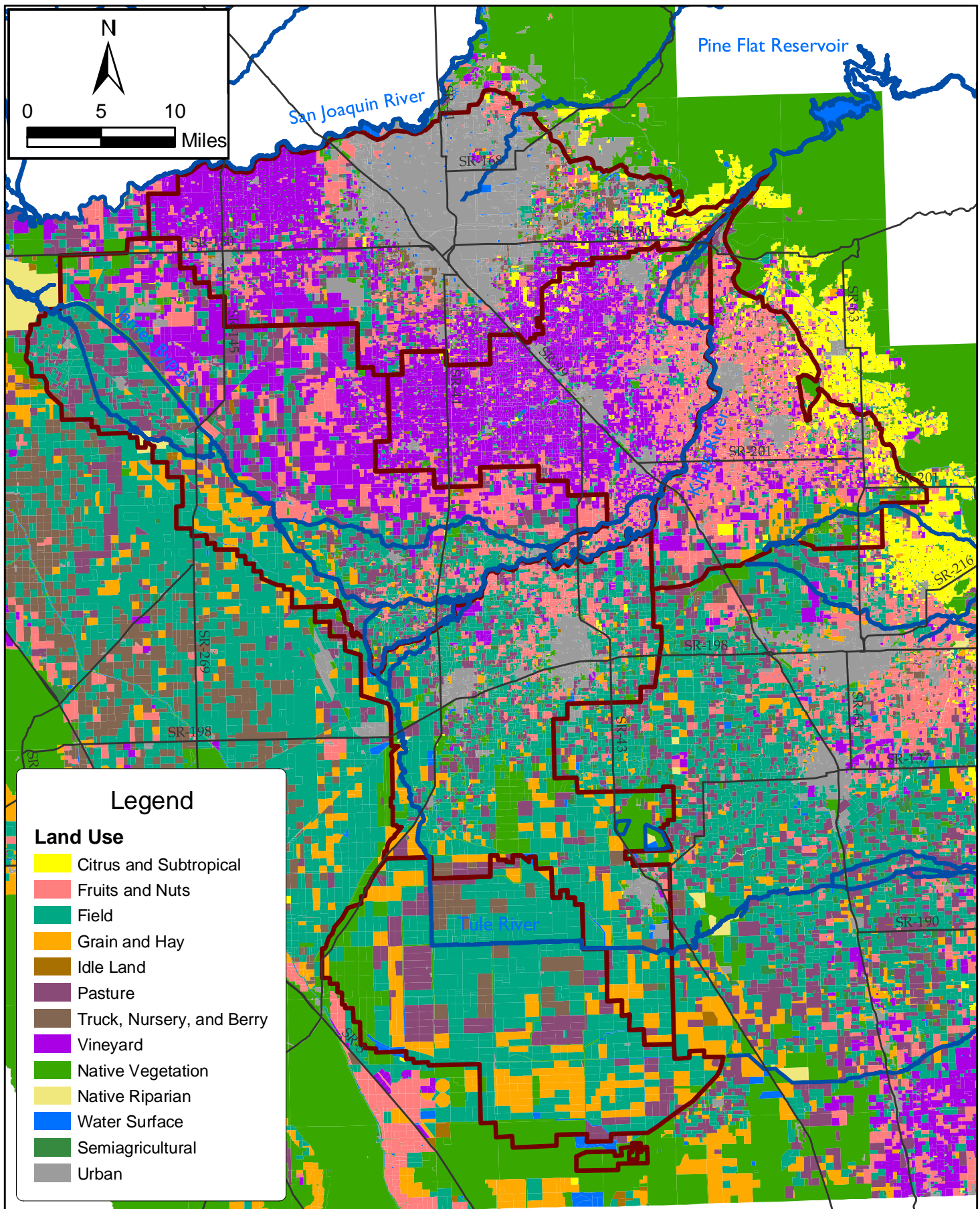
		WMA A		WMA A1		WMA B		WMA B1		WMA B2		WMA C		WMA C1	
	Water Duty	Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand
	AF/ac	ac	AF	ac	AF	ac	AF	ac	AF	ac	AF	ac	AF	ac	AF
Agriculture		104,960	318,081	36,644	117,255	56,533	160,661	48,796	155,736	33,800	107,849	46,542	140,253	18,641	49,676
Citrus and Subtropical	3.5	36	128	0	0	0	0	23	79	47	164	76	266	15	54
Deciduous	4.0	19,197	76,790	912	3,646	4,490	17,959	6,993	27,973	13,080	52,319	1,547	6,187	0	0
Field Crops	2.5	17,946	44,864	21,392	53,479	24,579	61,447	22,177	55,443	3,194	7,984	27,066	67,665	8,830	22,075
Grain	1.5	2,157	3,236	298	446	9,199	13,799	2,712	4,068	85	127	4,134	6,201	4,971	7,457
Idle	0.0	463	0	0	0	570	0	609	0	353	0	0	0	0	0
Pasture and Alfalfa	5.1	15,945	81,320	10,332	52,694	9,823	50,099	11,363	57,949	3,020	15,402	10,339	52,731	3,436	17,525
Semi Ag	2.0	2,689	5,378	463	926	841	1,682	3,106	6,213	1,066	2,132	1,373	2,746	334	669
Truck and Nursery	1.8	1,289	2,321	2,817	5,070	989	1,780	318	573	159	285	319	575	1,054	1,897
Vineyards	2.3	45,237	104,045	432	993	6,041	13,895	1,495	3,439	12,798	29,435	1,688	3,883	0	0
Other		4,899	0	1,275	0	2,600	0	3,493	0	283	0	6,100	0	2,070	0
Native Vegetation	0.0	4,562	0	564	0	394	0	2,475	0	214	0	4,625	0	1,491	0
Native Riparian	0.0	122	0	448	0	1,698	0	369	0	7	0	712	0	270	0
Water Surface	0.0	215	0	263	0	509	0	648	0	63	0	764	0	309	0
Municipal		2,408	3,051	788	1,392	725	1,237	1,810	3,143	375	584	4,686	7,602	372	511
Developed	2.0	1525	3052	696	1392	620	1237	1572	3144	292	585	3801	7601	256	511
Vacant	0.0	883	0	91	0	106	0	239	0	83	0	885	0	117	0
Average Water Duty		2.9		3.1		2.7		2.9		3.1		2.6		2.4	
TOTAL		112,268	321,133	38,707	118,647	59,858	161,898	54,099	158,880	34,459	108,433	57,328	147,854	21,083	50,187

Table C.2. Projected Land Use Summary

	Water Duty	WMA A		WMA A1		WMA B		WMA B1		WMA B2		WMA C		WMA C1	
		Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand	Area	Water Demand
		AF/ac	ac	AF	ac	AF	ac	AF	ac	AF	ac	AF	ac	AF	ac
Agriculture		104,552	317,011	36,197	115,683	56,414	160,364	45,061	143,697	33,800	107,849	39,757	116,613	18,641	49,676
Citrus and Subtropical	3.5	36	128	0	0	0	0	23	79	47	164	71	249	15	54
Deciduous	4.0	19,132	76,527	872	3,486	4,490	17,959	6,611	26,445	13,080	52,319	1,160	4,639	0	0
Field Crops	2.5	17,919	44,796	21,138	52,844	24,460	61,150	20,440	51,100	3,194	7,984	23,629	59,071	8,830	22,075
Grain	1.5	2,157	3,236	298	446	9,199	13,799	2,536	3,804	85	127	3,914	5,871	4,971	7,457
Idle	0.0	463	0	0	0	570	0	485	0	353	0	0	0	0	0
Pasture and Alfalfa	5.1	15,938	81,285	10,181	51,922	9,823	50,098	10,311	52,586	3,020	15,402	7,863	40,103	3,436	17,525
Semi Ag	2.0	2,675	5,350	461	921	841	1,682	2,885	5,770	1,066	2,132	1,122	2,244	334	669
Truck and Nursery	1.8	1,289	2,321	2,817	5,070	989	1,780	318	573	159	285	319	575	1,054	1,897
Vineyards	2.3	44,943	103,369	432	993	6,041	13,895	1,452	3,340	12,798	29,435	1,679	3,861	0	0
Other		4,899	0	1,269	0	2,600	0	3,158	0	283	0	4,480	0	2,070	0
Native Vegetation	0.0	4,562	0	558	0	394	0	2,182	0	214	0	3,018	0	1,491	0
Native Riparian	0.0	122	0	448	0	1,698	0	327	0	7	0	699	0	270	0
Water Surface	0.0	215	0	263	0	509	0	648	0	63	0	764	0	309	0
Municipal		2,816	3,867	1,241	2,327	844	1,475	5,880	11,363	375	584	13,091	25,904	372	511
Developed	2.0	1525	3052	696	1392	620	1237	1572	3144	292	585	3801	7601	256	1525
Vacant	0.0	883	0	78	0	106	0	199	0	83	0	139	0	117	0
Average Water Duty		3.0		3.0		3.0		3.0		3.0		2.0		2.0	
TOTAL		112,268	320,878	38,707	118,010	59,858	161,839	54,099	155,060	34,459	108,433	57,328	142,517	21,083	50,187

Formation Commission (LAFCO) and individual cities)(Kings Co. Planning Agency, 2005; KRCD, 2004). The Fresno County LAFCO is responsible for managing growth in urban areas within Fresno County. Each city within Fresno County has a sphere of influence (SOI) that defines a boundary for projected urban growth.

The purposes of analyzing projected land use, it was assumed that the crop mix for agricultural areas remained unchanged (except in those areas converted to urban land use). Table C.2 shows the projected agricultural, urban, and other land use areas and their associated demands for each WMA in the Lower Kings Basin.

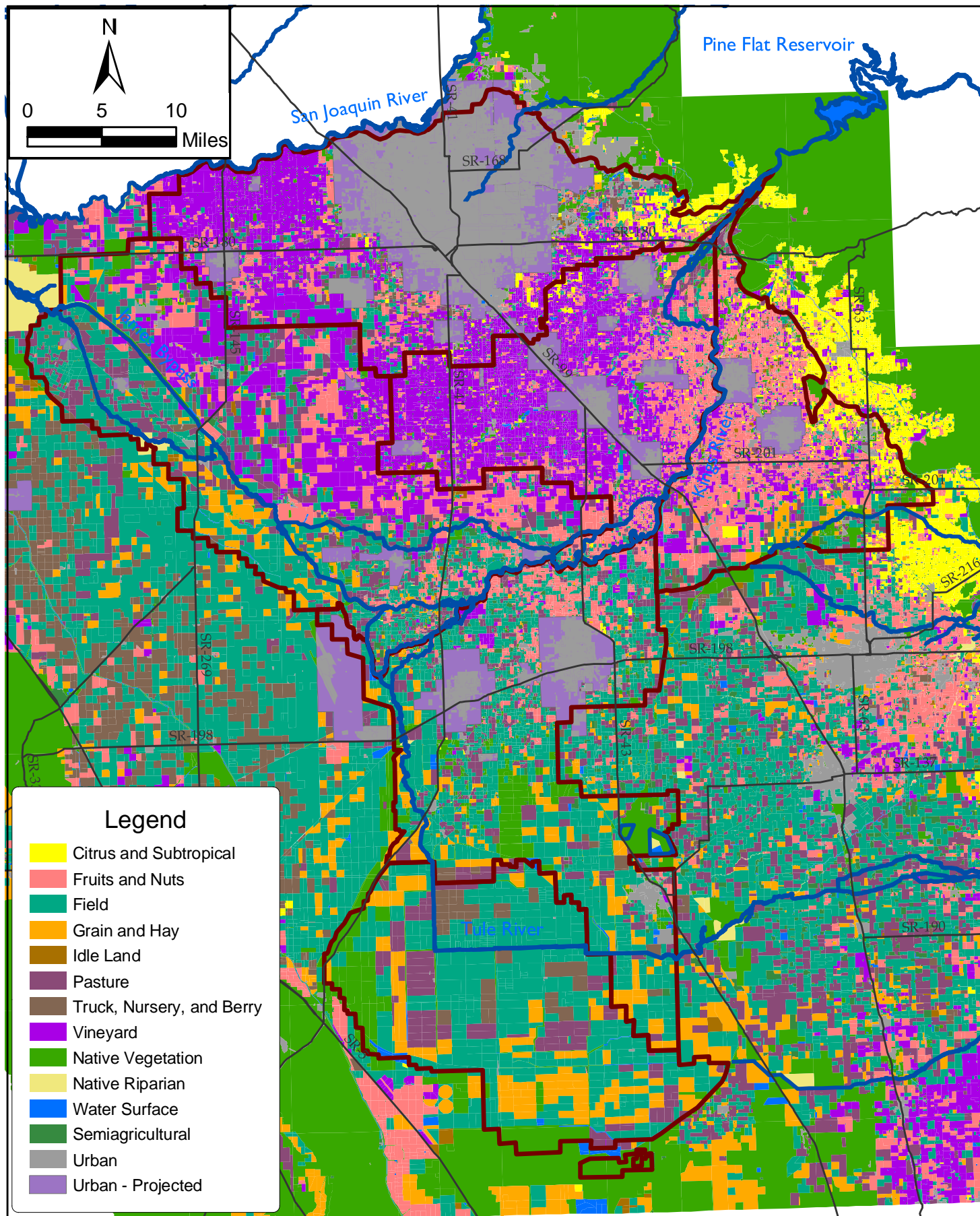


Lower Kings Basin GWMP Update

Detailed Land Use

April 2005

Figure C.1



Lower Kings Basin GWMP Update
Detailed Projected Land Use

April 2005

Figure C.2

D.1 GROUNDWATER OCCURRENCE AND MOVEMENT

This appendix documents the analysis of groundwater resources in the Lower Kings Basin. Evaluations were made of hydrographs, groundwater trends, and changes in groundwater storage. The analyses were used to support the conclusions and management actions made in the Lower Kings Basin GWMP and during review of the previous groundwater management plans. The analyses were also used to establish Basin Management Objectives, action thresholds, and management criteria in the latest Lower Kings Basin groundwater management plan. All referenced figures are included at the end of the appendix.

Groundwater is generally unconfined within the alluvial fan deposits (older and younger alluvium). Groundwater in the deeper continental deposits is unconfined to semiconfined with the degree of confinement generally increasing with depth. Groundwater conditions at specific locations vary from regional patterns because of localized hydrogeologic conditions and groundwater pumping. Figure D.1 shows depth to groundwater contours in the Lower Kings Basin for spring 2003. Data to develop groundwater related contours were obtained from DWR (California Water Data Library). The depth to groundwater in spring 2003 varies from less than 40 feet near the Kings River at the eastern edge of the basin to more than 200 feet at several different locations. West in the Lower Kings Basin, the depth to groundwater near Mendota Pool is less than 20 feet.

Groundwater moves from sources of recharge to sources of discharge and/or withdrawal. Thus, recharge areas generally have higher groundwater elevations than do discharge areas or areas with high volumes of withdrawal. Figure D.2 shows groundwater elevation contours for spring 1950. Figure D.2 show that the regional groundwater flow pattern is from east to west. Figures D.3 through D.7 show groundwater level contours in subsequent years. The highest groundwater levels are located along the eastern boundary of the Lower Kings Basin. The lowest groundwater elevations are located at the Raisin City.

Groundwater pumping has altered the natural flow of the groundwater system and cones of depression have formed in areas that don't have sufficient recharge. The most pronounced of these areas is in Raisin City WD. Additionally, there are several smaller cones of depressions in and near the Lower Kings Basin due to smaller scale withdrawals of groundwater. There are few groundwater mounds and they are associated with areas of recharge.

Since 1989, KRCD has used groundwater level data, both from their monitoring efforts and from DWR, to produce annual groundwater reports. These reports include regional water level maps showing historical and existing groundwater levels. Figure D.2 shows groundwater conditions before significant groundwater pumping occurred in the basin. The spring 1950 groundwater levels were compared with the spring 2000 groundwater levels (Figure D.7) and the difference between groundwater levels is shown in Figure D.8. Figure D.8 shows that there has been significant reduction in groundwater levels in the Lower Kings Basin

Figure D.9 shows the location of 965 wells in the Lower Kings Basin. These wells represent the number of wells with water level measurement data. Of the 965 wells in the Lower Kings Basin, 566 of them do not have measurement more recent than 2000 and 590 of them do not have more than ten recorded measurements.

D.2 ANALYSIS OF GROUNDWATER LEVELS

The purpose of this analysis was to evaluate the groundwater conditions in the Lower Kings Basin. The process for conducting the analysis included:

1. Locating wells within the different planning areas within the Lower Kings Basin;
2. Identifying groundwater wells with a record of water level measurements;
3. Applying selection criteria;
4. Obtaining well construction logs for selected wells;
5. Calculating the average water level measurements using wells located within a specific planning area. Two averages per water year were calculated. An average water level was calculated for measurements taken between January and June (referred to as Spring average). The Fall average water level was calculated from measurements taken between July and December;
6. Preparing hydrographs of average groundwater levels were developed for planning area; and
7. Developing trend lines of average groundwater levels and forecast future groundwater levels.

DETAILS OF ANALYSIS

Groundwater level data were obtained the 965 wells listed above. The periods of record for these extended from the 1920s to present. Criteria were applied to determine which wells would be selected for additional analysis. These criteria were:

- The wells needed to have been measured for at least thirty years;

- Groundwater levels need to have been measured at least 40 times during the 30 year period; and
- Groundwater levels need to have been measured since 1999.

136 wells satisfied the aforementioned criteria and were used for additional analysis and evaluation. It was assumed that these 136 wells are representative of the groundwater conditions in their respective WMA. Well construction logs were obtained from DWR and the well construction depth and perforation intervals for the selected wells were recorded. Figure D.10 shows the location of the wells used in the analysis. Figures D.11 through D.25 show groundwater level hydrographs for the highlighted wells shown on D.10.

Figure D.26 through E.32 shows the resulting average groundwater level hydrograph for each area. The hydrographs, which start in 1950, are used to show the predominant trends in the groundwater system. A trend line was calculated based on the average groundwater levels. The trend lines were projected out to 2030 to provide a forecast of future groundwater levels. The figures also show features associated with the BMOs.

WMA A hydrograph shows that the average groundwater levels has declined from approximately 180 feet above mean sea level (msl) in 1950 to 60 feet in 2005. The groundwater level trend for WMA A indicates that groundwater levels will continue to decline into the future with groundwater levels of 30 feet above msl by the year 2030.

WMA A1 hydrograph shows that the average groundwater levels has declined from approximately 100 feet above mean sea level (msl) in 1950 to 80 feet in 2005. The groundwater level trend for WMA A1 does not appreciably decline into the future.

WMA B hydrograph shows that average groundwater levels has declined from 160 feet msl in 1950 to 20 feet msl in 2005. The groundwater level trend for WMA B indicates that groundwater levels will continue to decline into the future with groundwater levels of 30 feet below msl by the year 2030.

WMA B1 hydrograph shows that there has been 30 feet decline in groundwater levels since 1950. The groundwater level trend for WMA B1 indicates that groundwater levels will continue to decline another 5 to 10 feet by the year 2030.

WMA B2 hydrograph shows that the average groundwater level has declined from 230 msl feet in 1950 to 170 feet msl in 2001. The groundwater level trend for WMA B2 indicates that groundwater levels will continue to decline 10 feet by 2030.

WMA C hydrograph shows that the average groundwater level has declined over 100 feet since 1950. The hydrograph shows that the greatest decrease in groundwater levels has occurred in the last 15 years.

WMA C1 hydrograph shows an increase in groundwater level of over 150 feet when current levels are compared with 1960 groundwater levels. The hydrograph shows that groundwater levels are highly sensitive to groundwater pumping during drought conditions with groundwater levels declining nearly 200 feet during the 1976-77 drought. Groundwater levels nearly recovered to pre-1976 levels by 1978. Groundwater levels during the 1987-1992 drought decreased over 225 feet and then subsequently rebounded 200 feet by 2000.

The trend lines are linear statistical fits to the hydrograph data. It was assumed as part of developing the trend lines that historical pumping trends and water management practices do not change in the future. More extensive hydrologic modeling of the groundwater system would be a better method for evaluating future trends.

Review of the well description files and well logs associated with 136 wells was conducted to better document well completion depth and perforation intervals for each well, and so water levels could be interpreted in context of Lower Kings Basin hydrogeology. This information was used to determine which aquifer or aquifers the water levels represent. Well log and construction data were poor and records were incomplete.

Groundwater levels have continued to decline since the construction of Pine Flat Dam and the reoperation of the reservoir in 1964. Groundwater levels are responsive to flow conditions in the Kings River and the overall hydrology of the basin and the reservoir has improved groundwater conditions. The declining water levels indicate that groundwater is pumped at a faster rate than the naturally occurring groundwater recharge rate. It can be interpreted from the groundwater level trend lines that groundwater levels will continue to decline into the future should there be no changes in current operation. Future groundwater levels are predicted to continue along historical patterns.

D.3 ANALYSIS OF GROUNDWATER STORAGE

The purpose for determining the change in groundwater storage was to provide a baseline condition for the groundwater system and to provide design targets for future groundwater recharge projects. The process for determining the change in groundwater storage was to:

- Determine the area, average specific yield, 1950, and 2005 average groundwater levels for each Water Management Area; and
- Multiply the difference in groundwater levels by area and specific yield.

Specific Yield data was obtained from KRCD (KRCD, 2005) and the distribution of specific yield in the Lower Kings Basin is shown in Figure D.33. Table D.1 shows the results of the analysis.

Table D.1. Summary of Groundwater Overdraft Evaluation

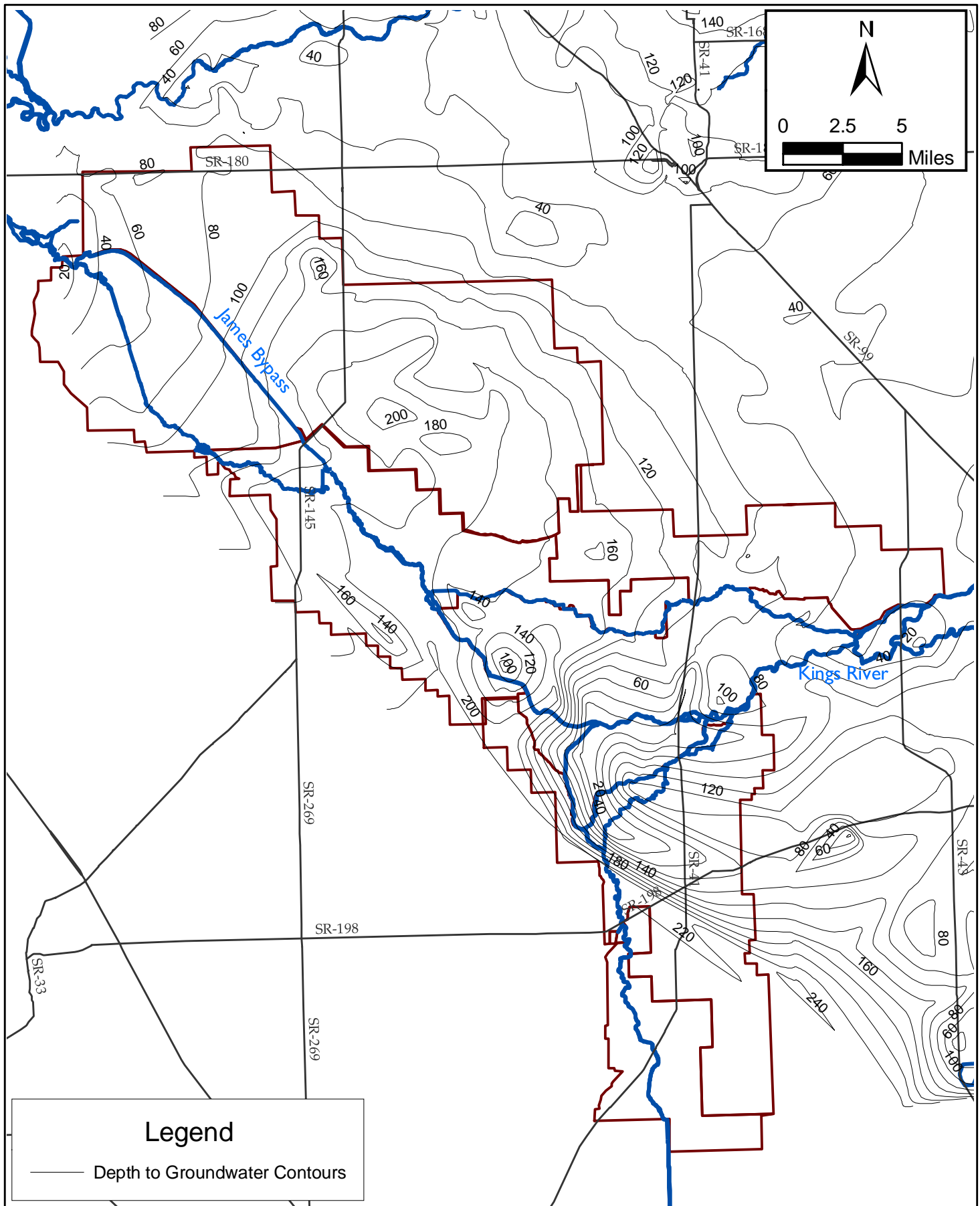
WMA	Area (acres)	Average Specific Yield (%)	Trend Line GW Level in 1950 (ft above msl)	Trend Line GW Level in 2005 (ft above msl)	Estimated Change in Storage (acre-feet)	Annual Change in Storage (Acre-feet/year)
A	112,268	12.0	184	47	-1,857,000	-34,000
A1	38,707	11.3	96	77	-82,000	-1,000
B2	34,459	15.5	215	168	-249,000	-5,000
B	59,858	11.5	158	36	-838,000	-15,000
B1	54,099	13.4	215	188	-194,000	-4,000
C	57,328	11.6	196	121	-501,000	-9,000

The negative change in storage indicates that groundwater was been removed from the groundwater system in excess of recharge. The change in storage also represents the potential volume of water that could be stored as part of future groundwater recharge programs. These potential programs will be evaluated using the integrated groundwater and surface water model planned for development by KRCD in conjunction with DWR.

D.4 SUMMARY OF FINDINGS

The following are findings from the conducted analyses:

1. Groundwater levels have declined steadily since 1950;
2. The construction and operation of Pine Flat Reservoir has not mitigated overdraft conditions in the Lower Kings Basin;
3. Groundwater levels are expected to decline in the future if current groundwater management practices remain unchanged;
4. Over 2 MAF of groundwater has been taken from storage and not recharged; and
5. The average annual rate of groundwater overdraft in the Lower Kings Basin 68 TAF/yr.



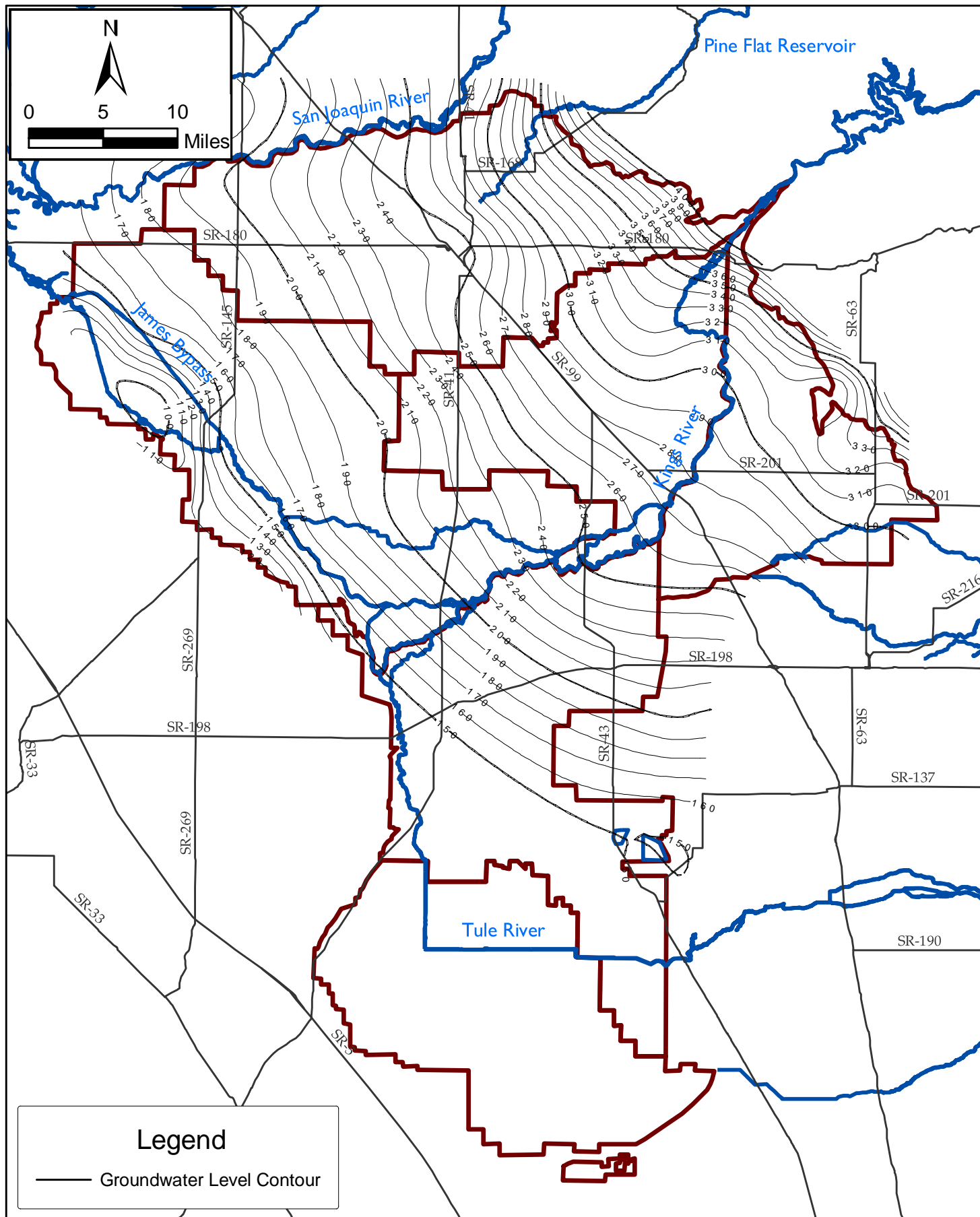
Lower Kings Basin GWMP Update

Depth to Groundwater Contours

Spring 2003

April 2005

Figure D.1



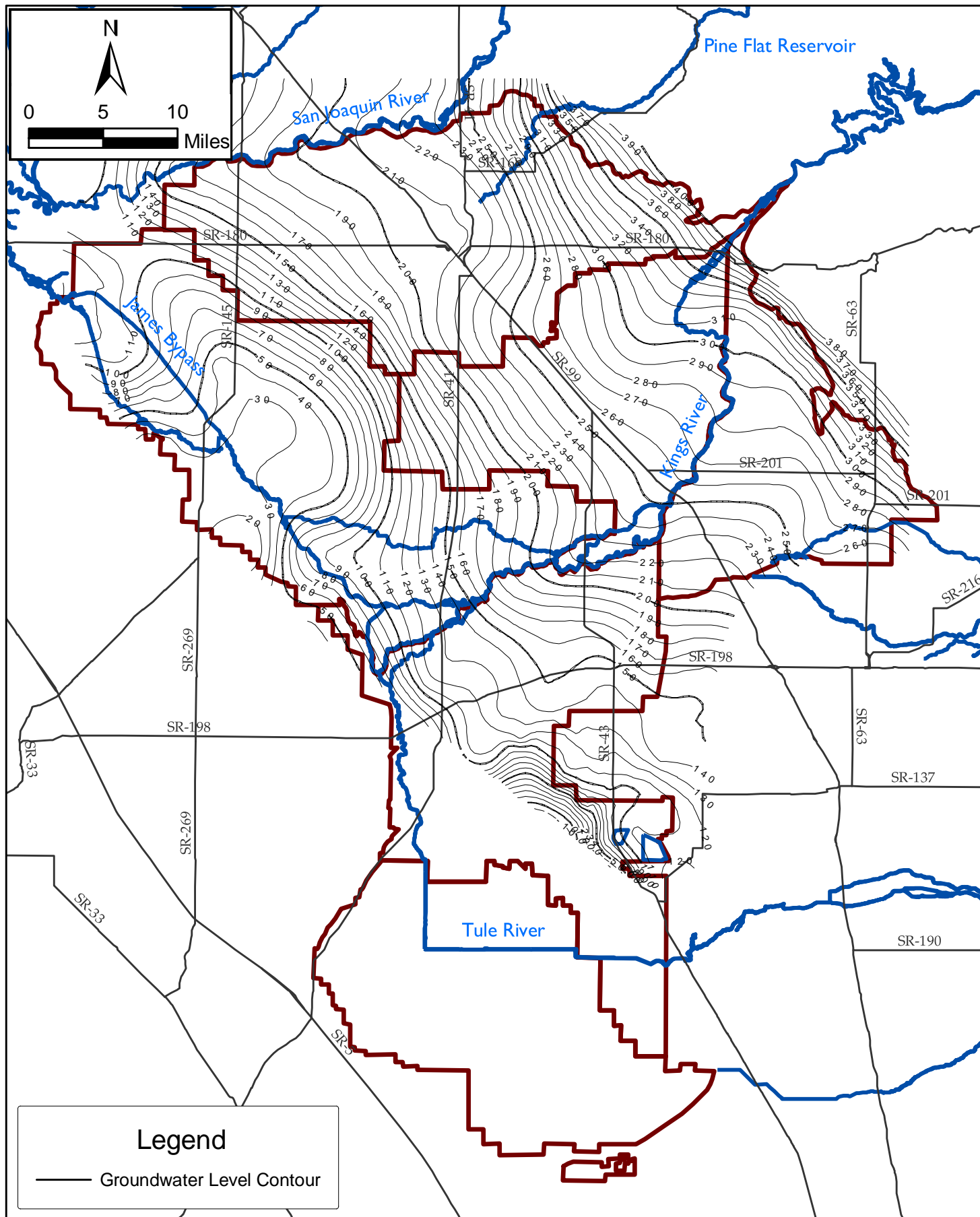
Lower Kings Basin GWMP Update

Groundwater Level Contours

Spring 1950

April 2005

Figure D.2



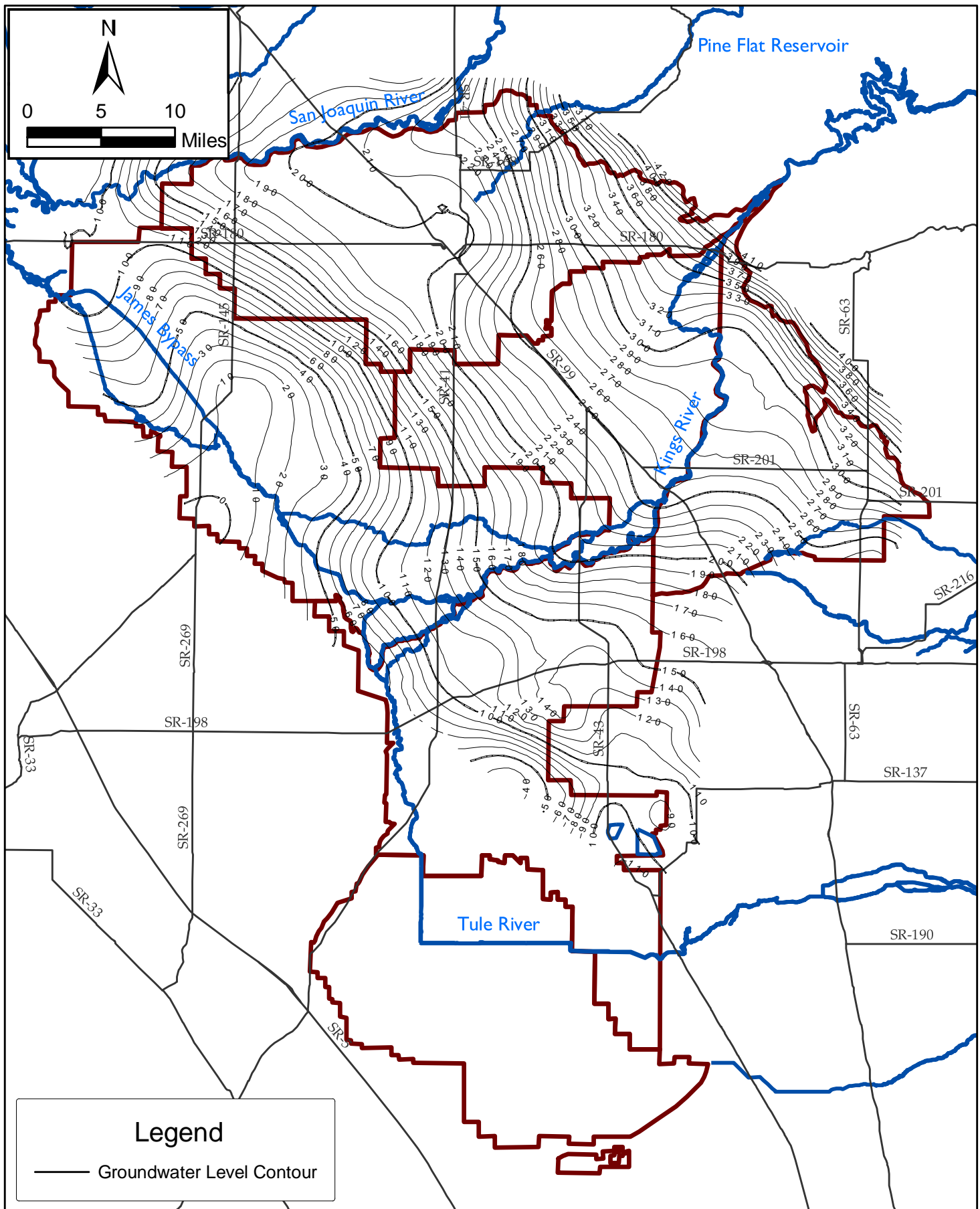
Lower Kings Basin GWMP Update

Groundwater Level Contours

Spring 1978

April 2005

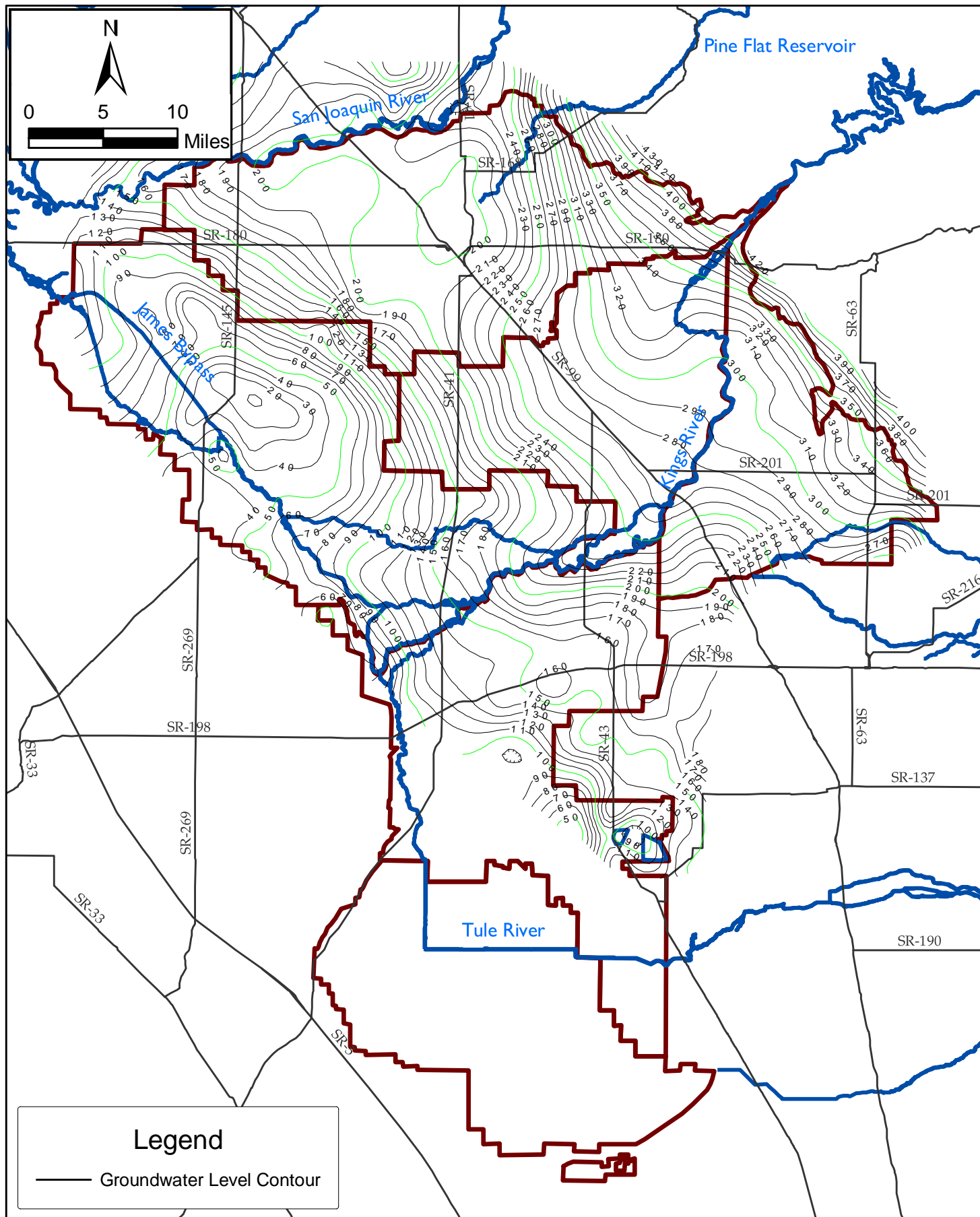
Figure D.4



Lower Kings Basin GWMP Update
Groundwater Level Contours
 Spring 1995

April 2005

Figure D.6



Lower Kings Basin GWMP Update

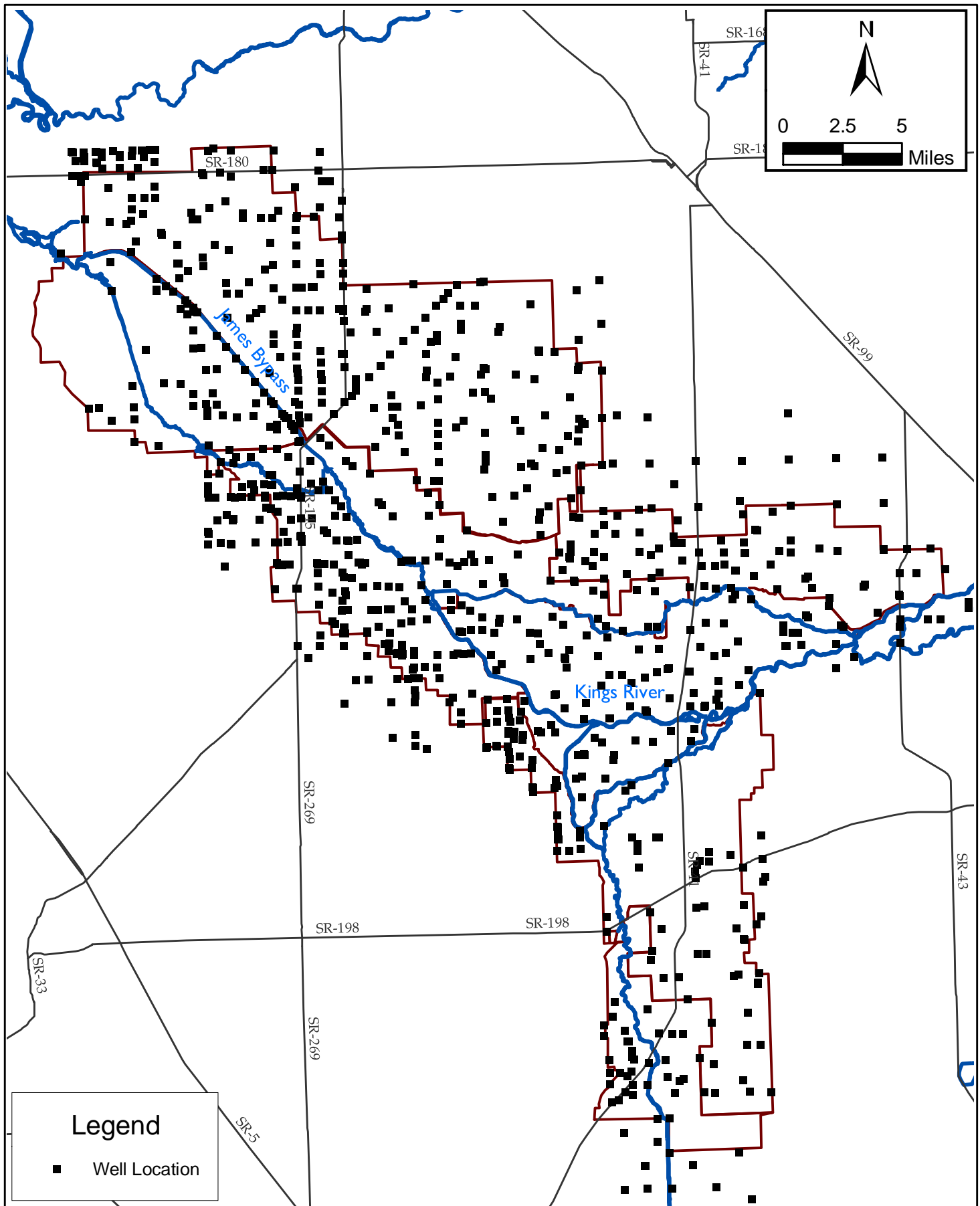
Groundwater Level Contours

Spring 2000

April 2005

Figure D.7



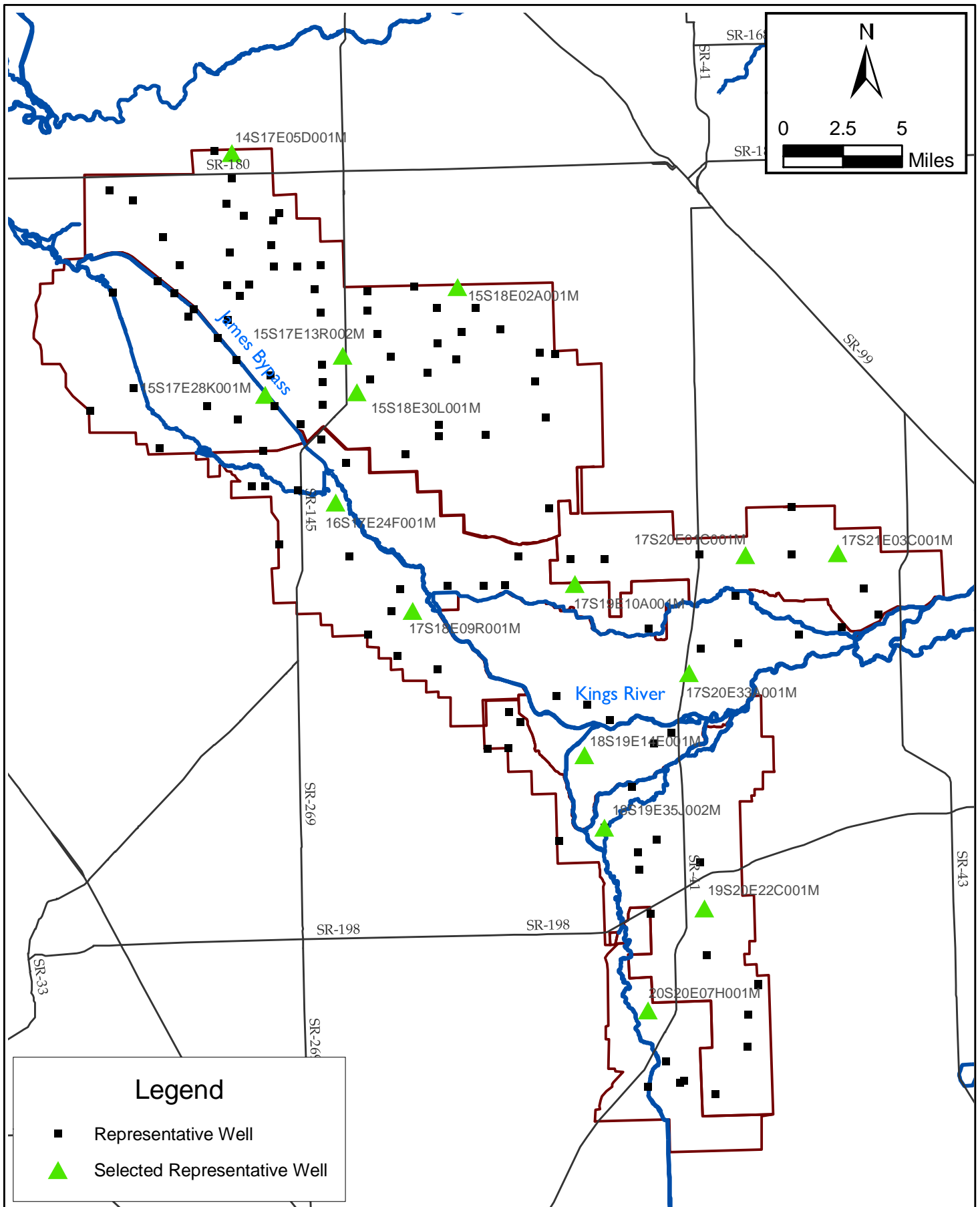


Lower Kings Basin GWMP Update

Location of Monitored Groundwater Wells

April 2005

Figure D.9

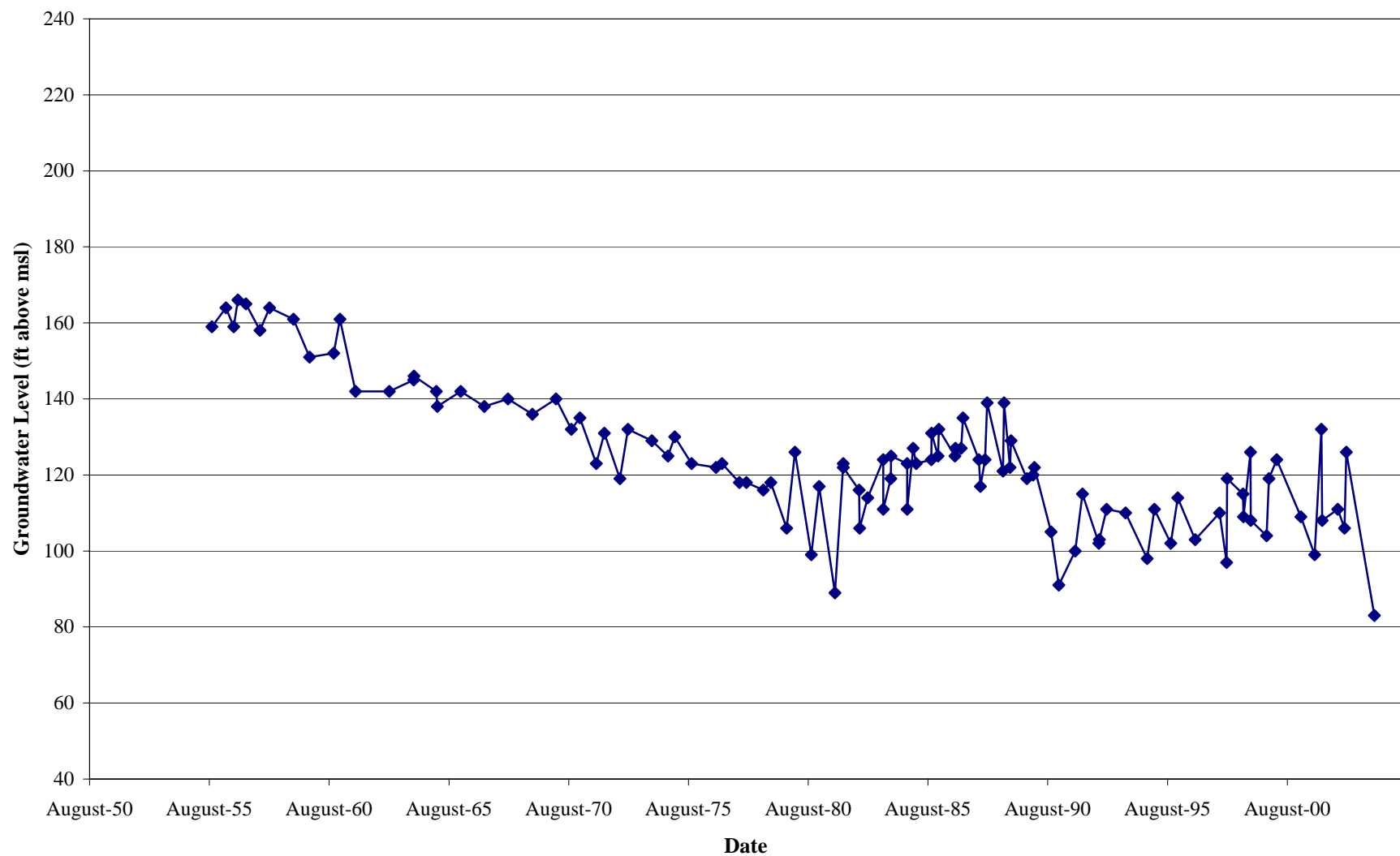


Lower Kings Basin GWMP Update

Location of Representative Groundwater Wells

April 2005

Figure D.10

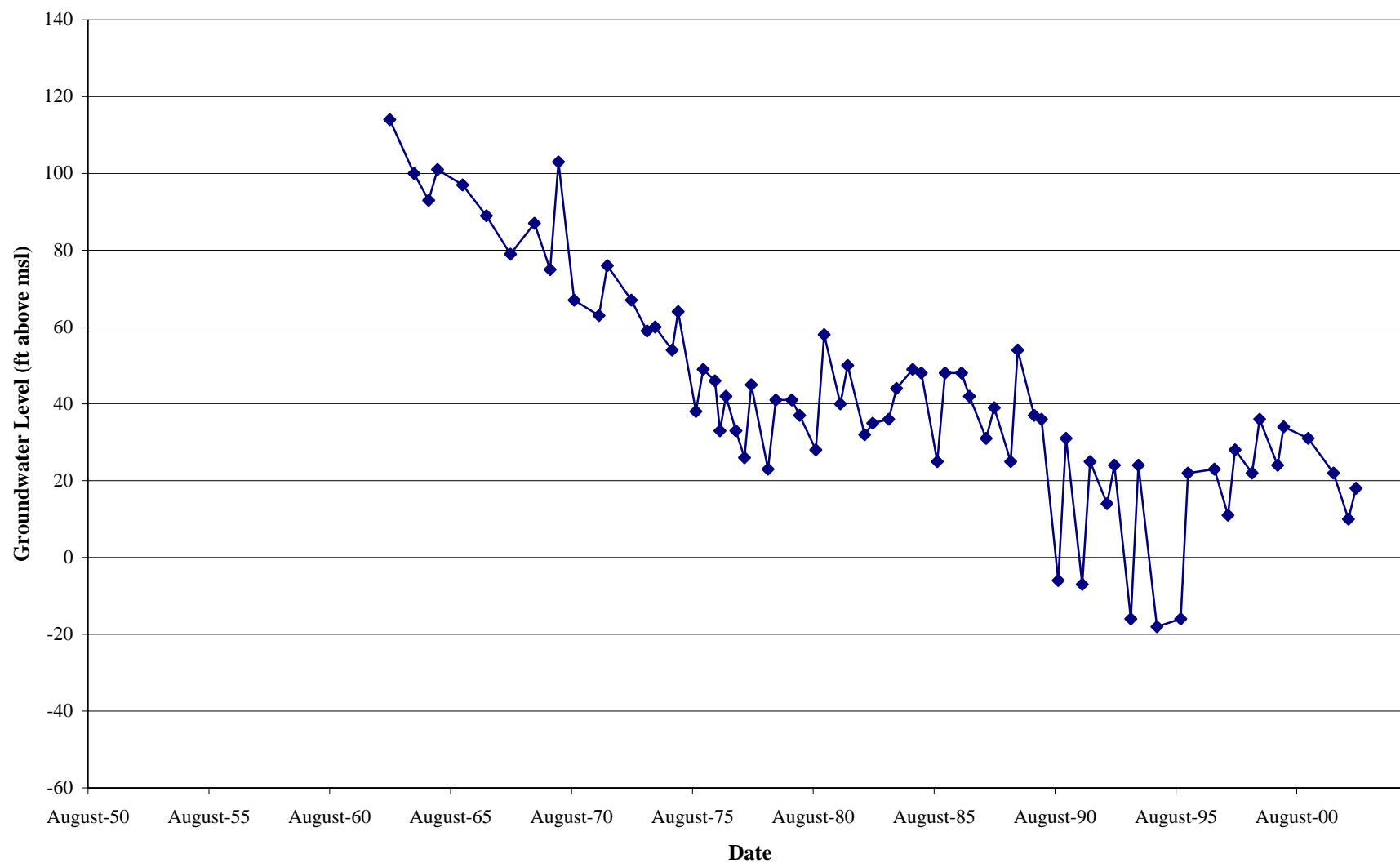


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 14S17E05D001M in WMA A

FIGURE D.11

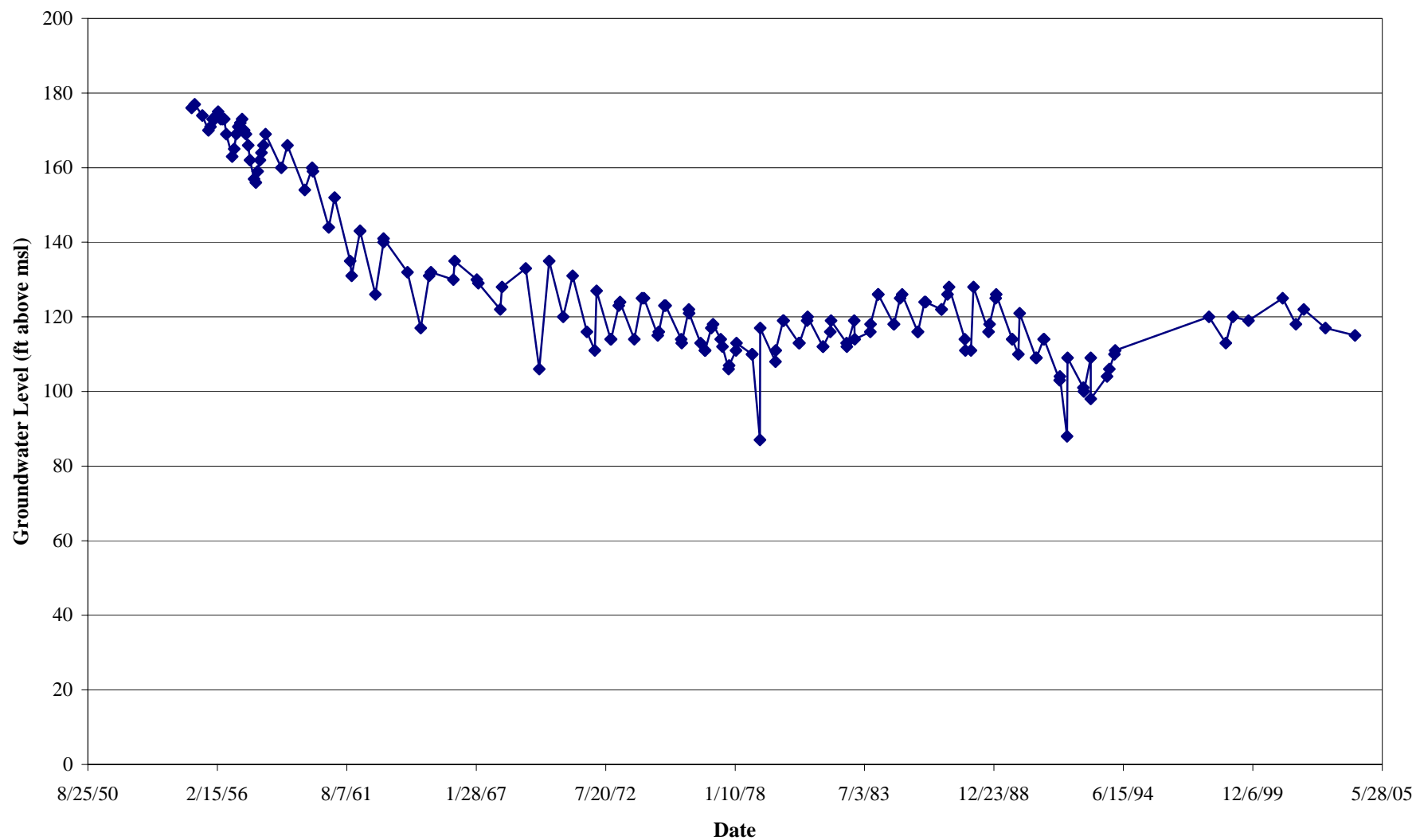


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 15S17E13R002M in WMA A

FIGURE D.12

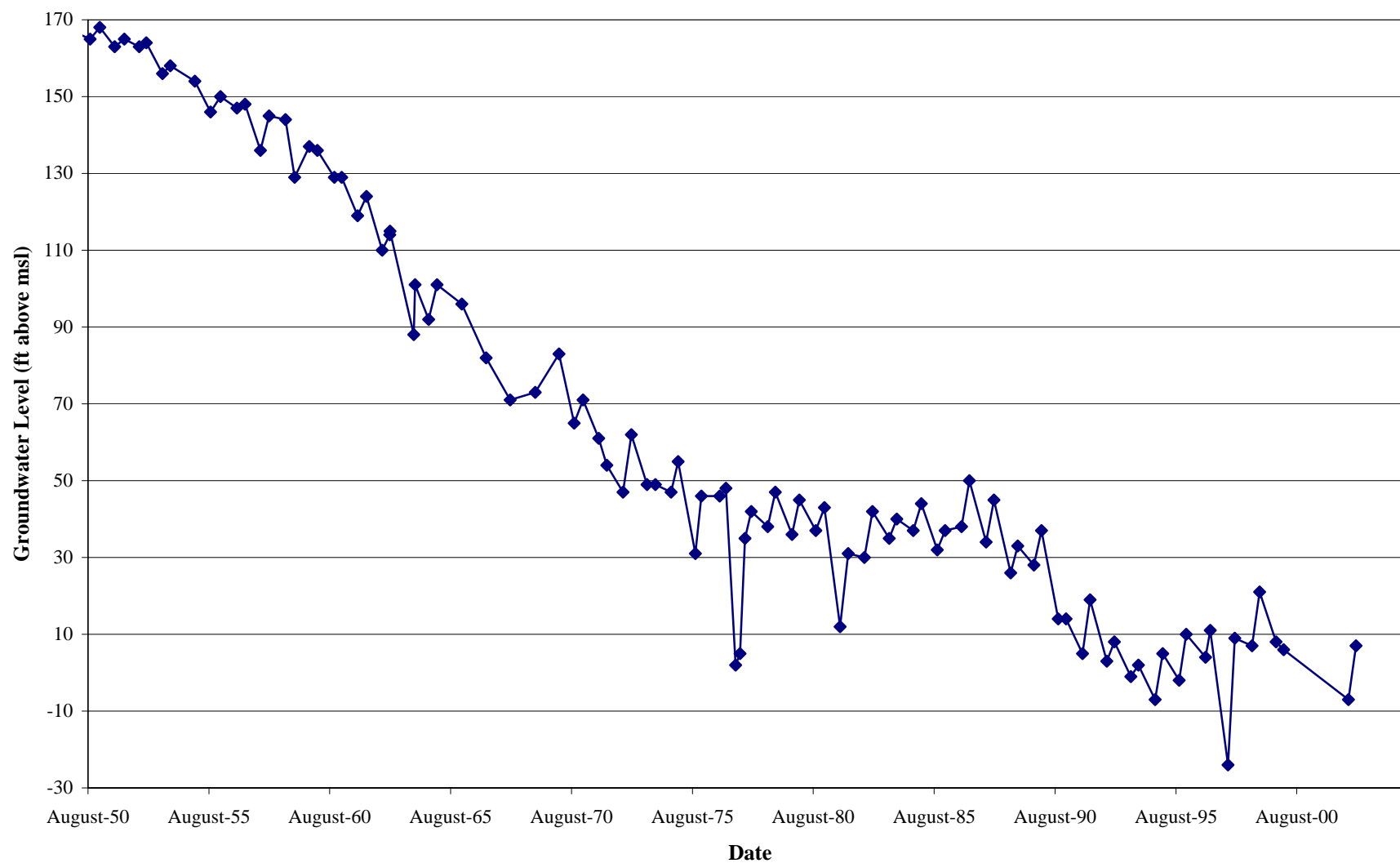


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 15S18E02A001M in WMA A

FIGURE D.13

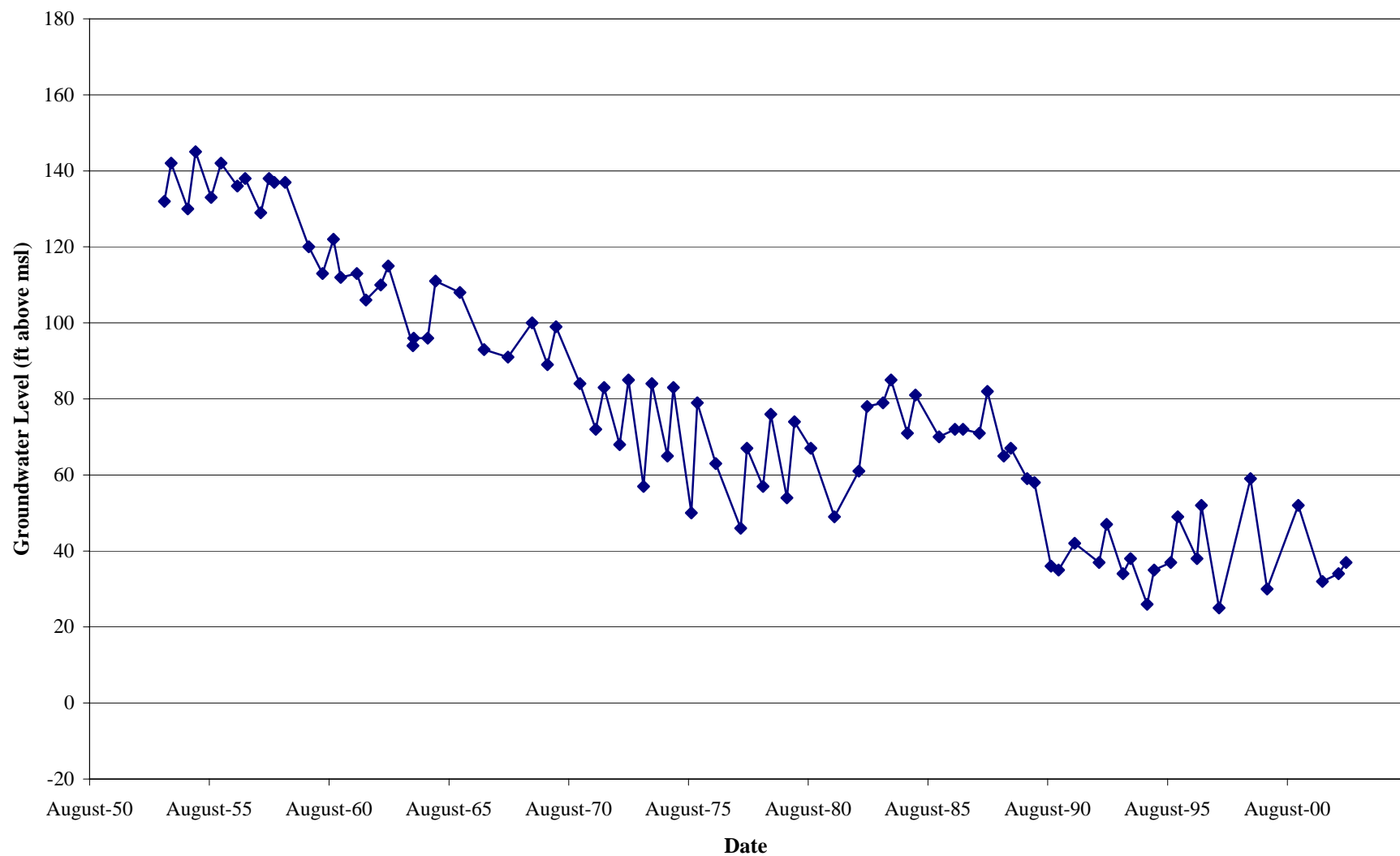


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 15S18E30L001M in WMA A

FIGURE D.14

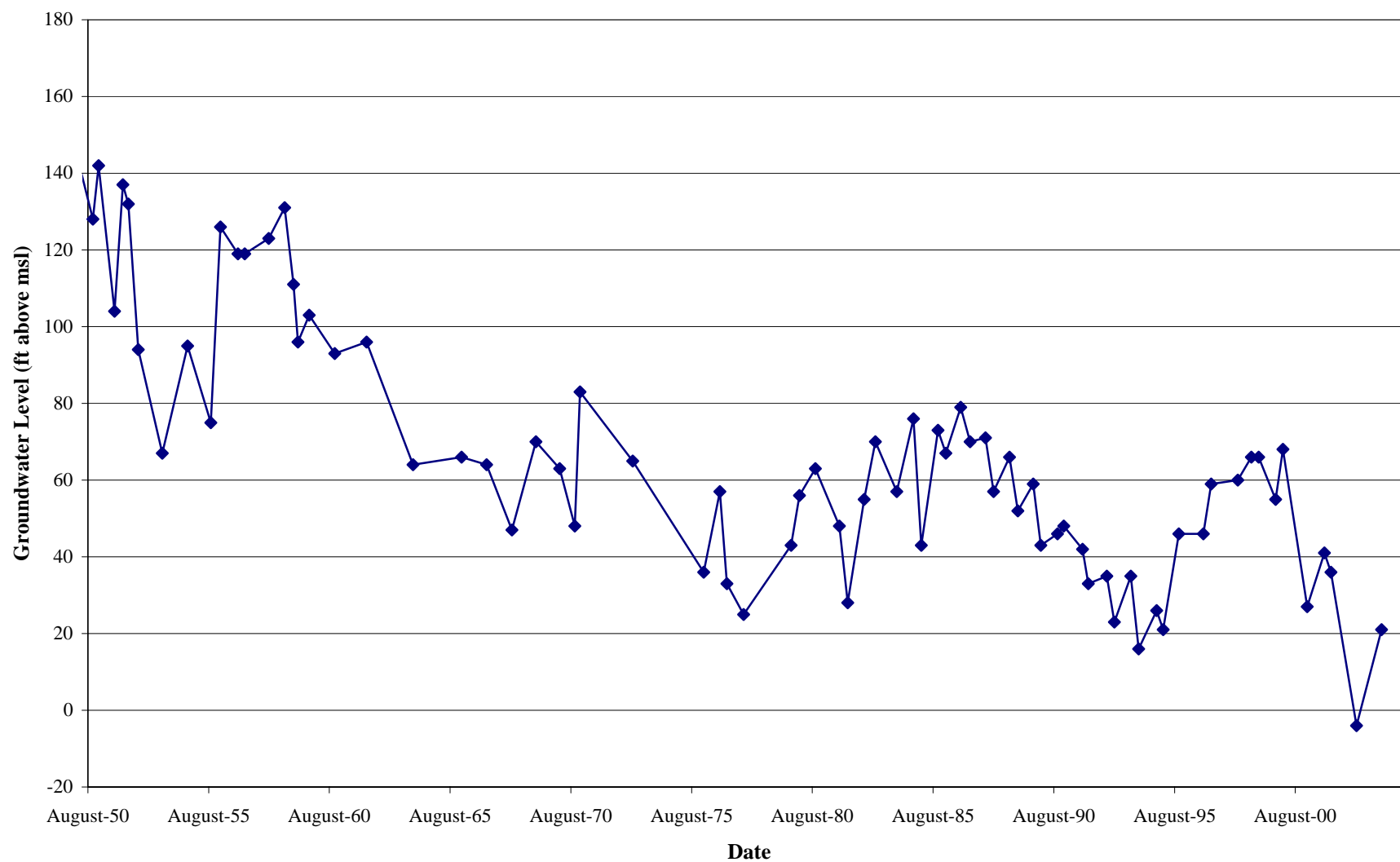


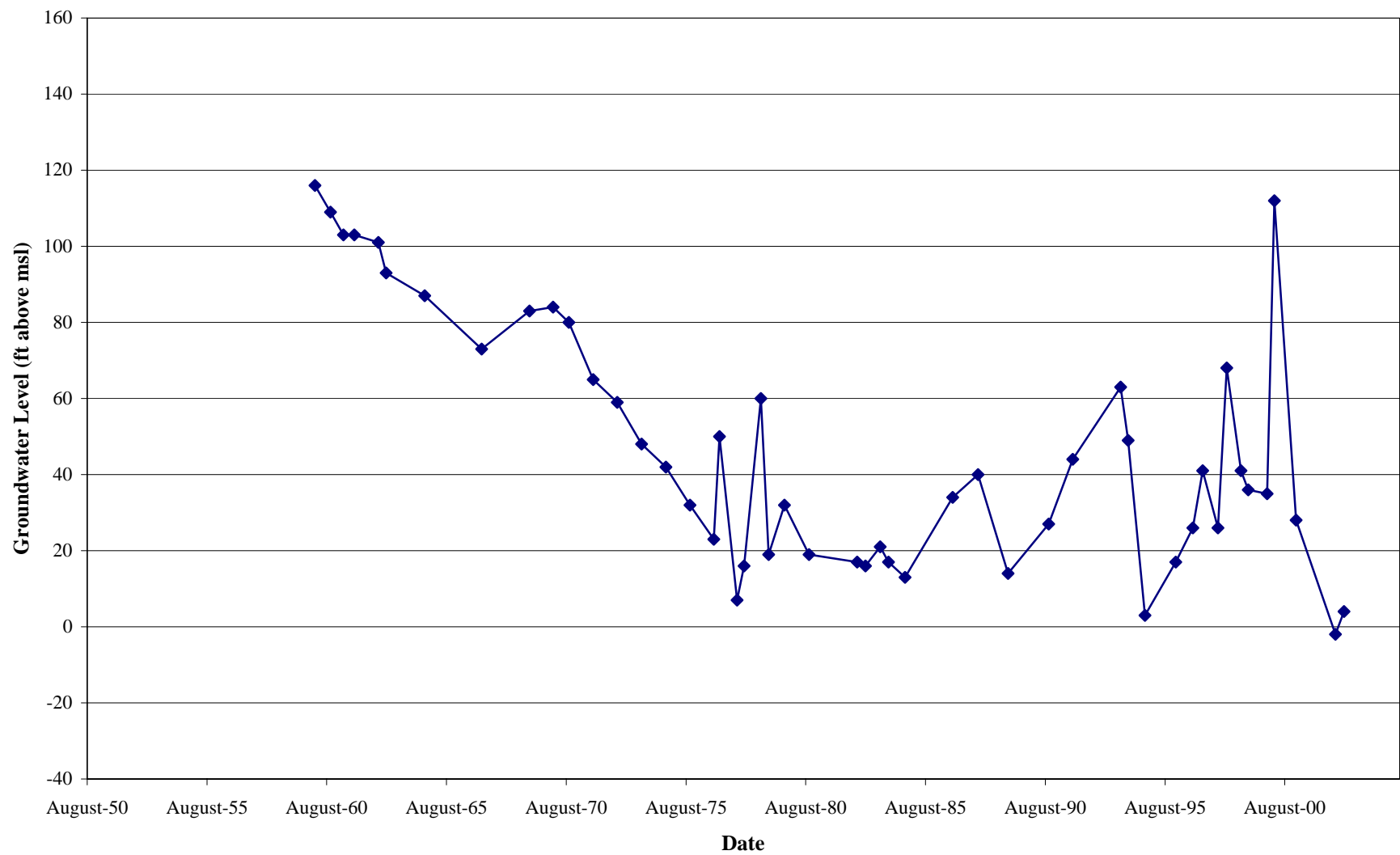
Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 15S17E28K001M in WMA A1

FIGURE D.15



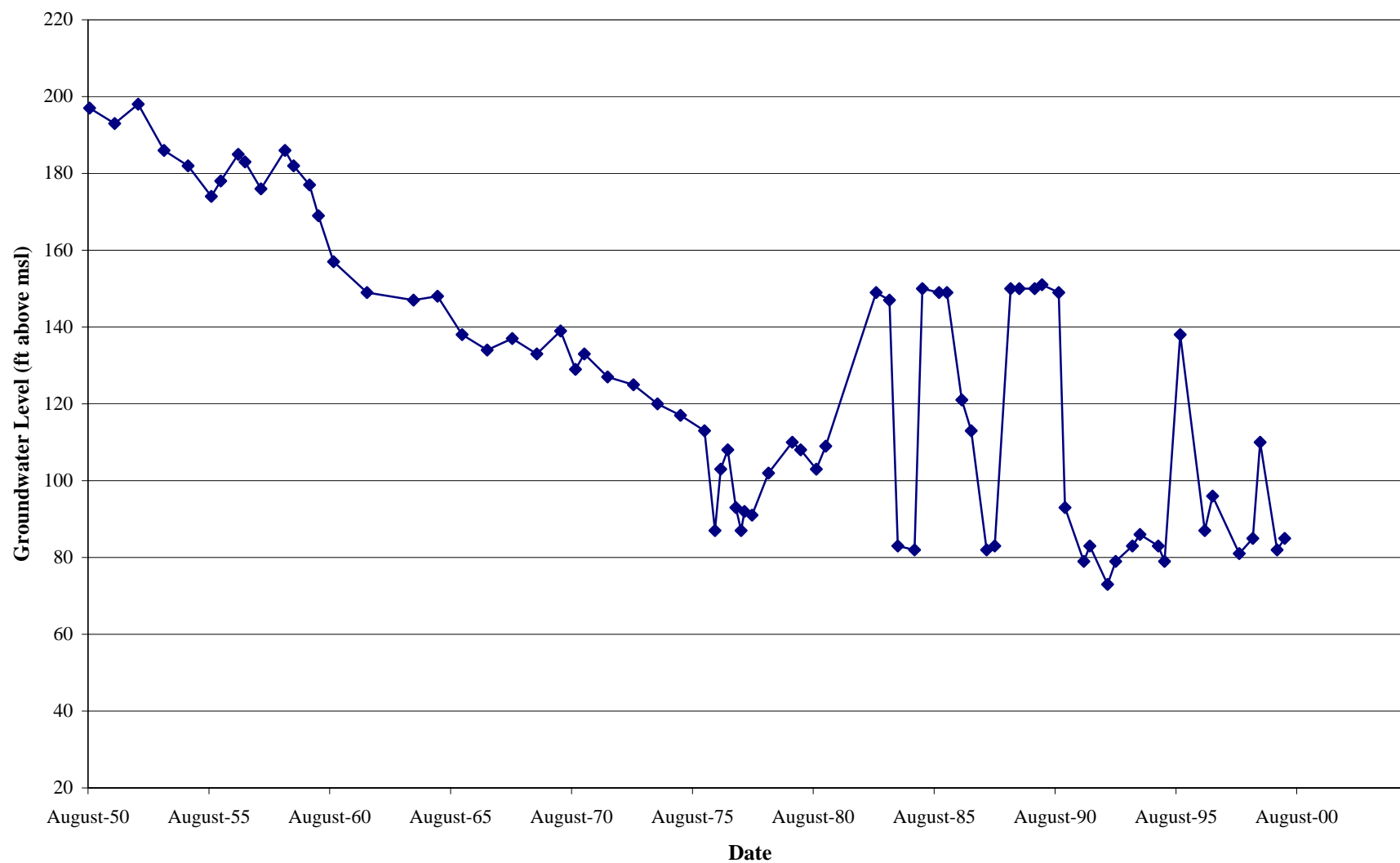


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 16S17E24F001M in WMA B

FIGURE D.17

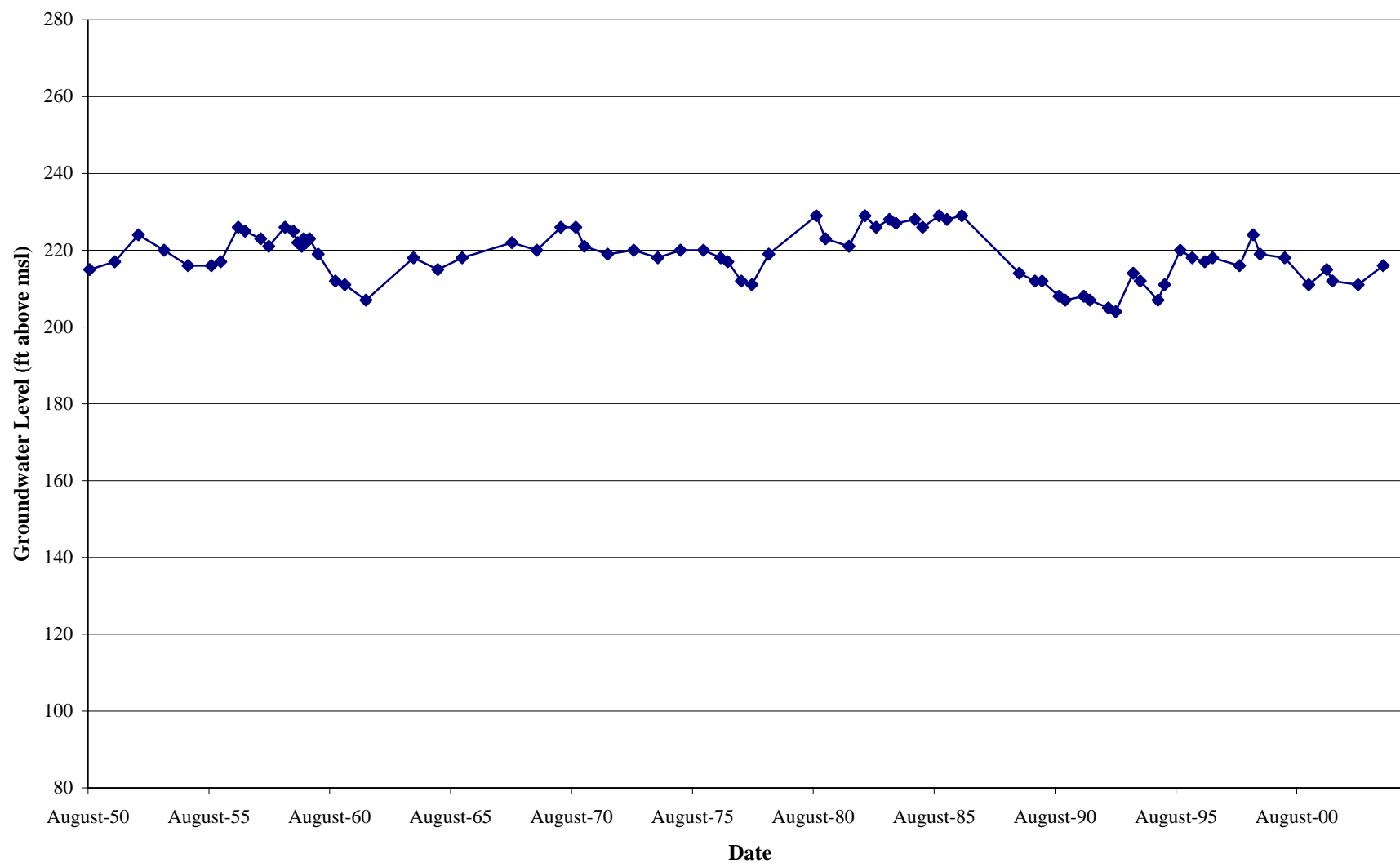


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 17S19E10A001M in WMA B

FIGURE D.18

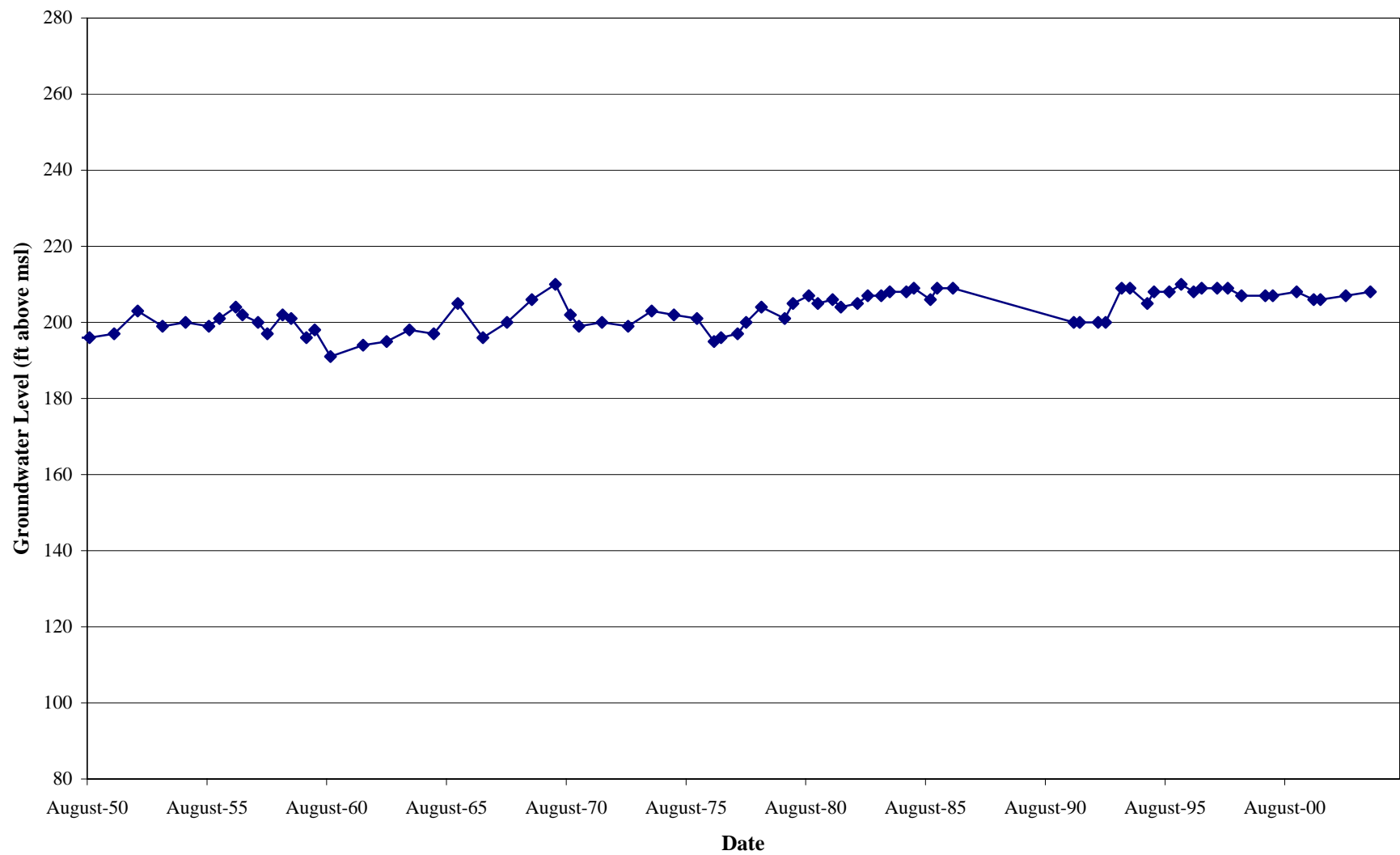


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 17S20E33A001M in WMA B1

FIGURE D.19

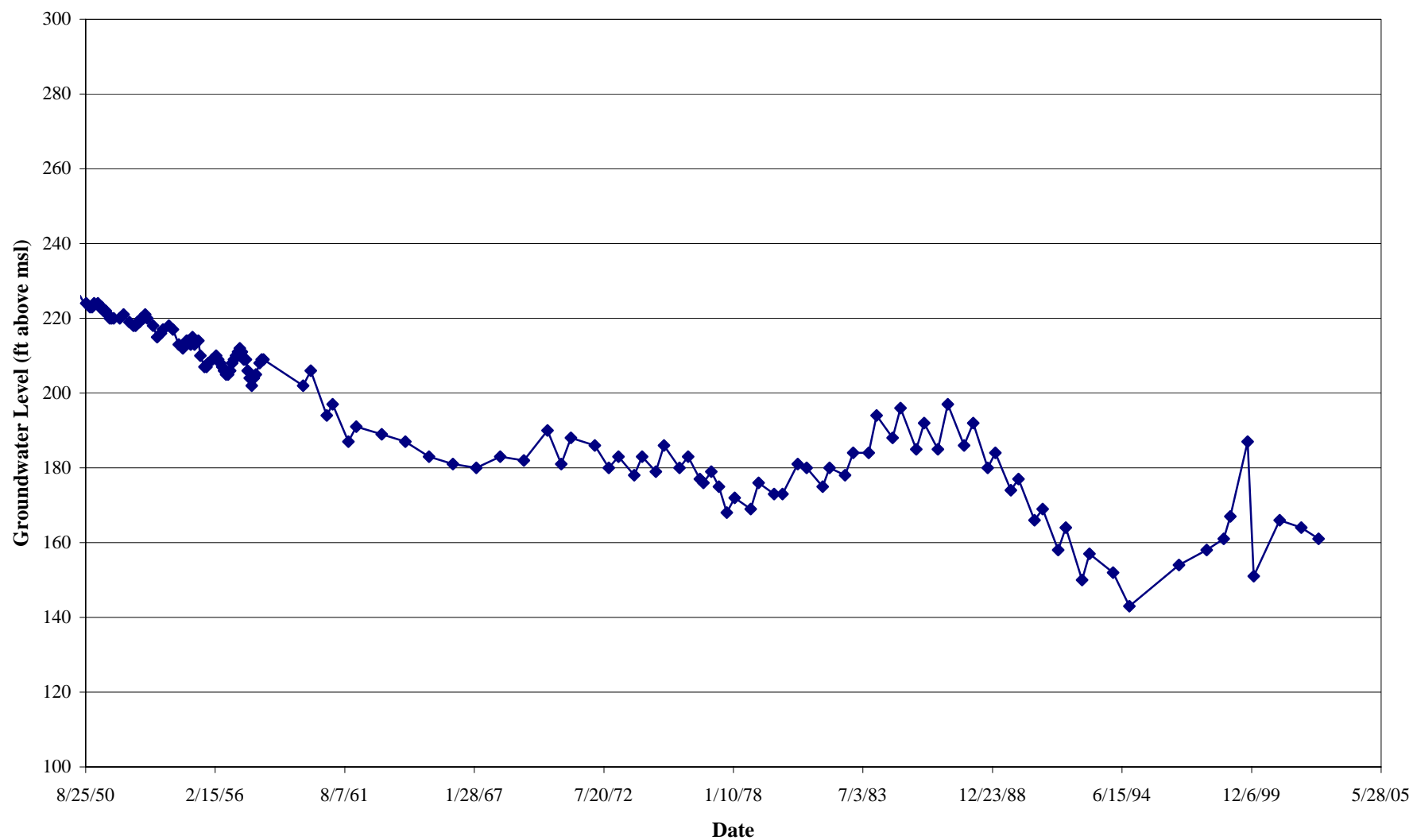


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 18S19E14E001M in WMA B1

FIGURE D.20

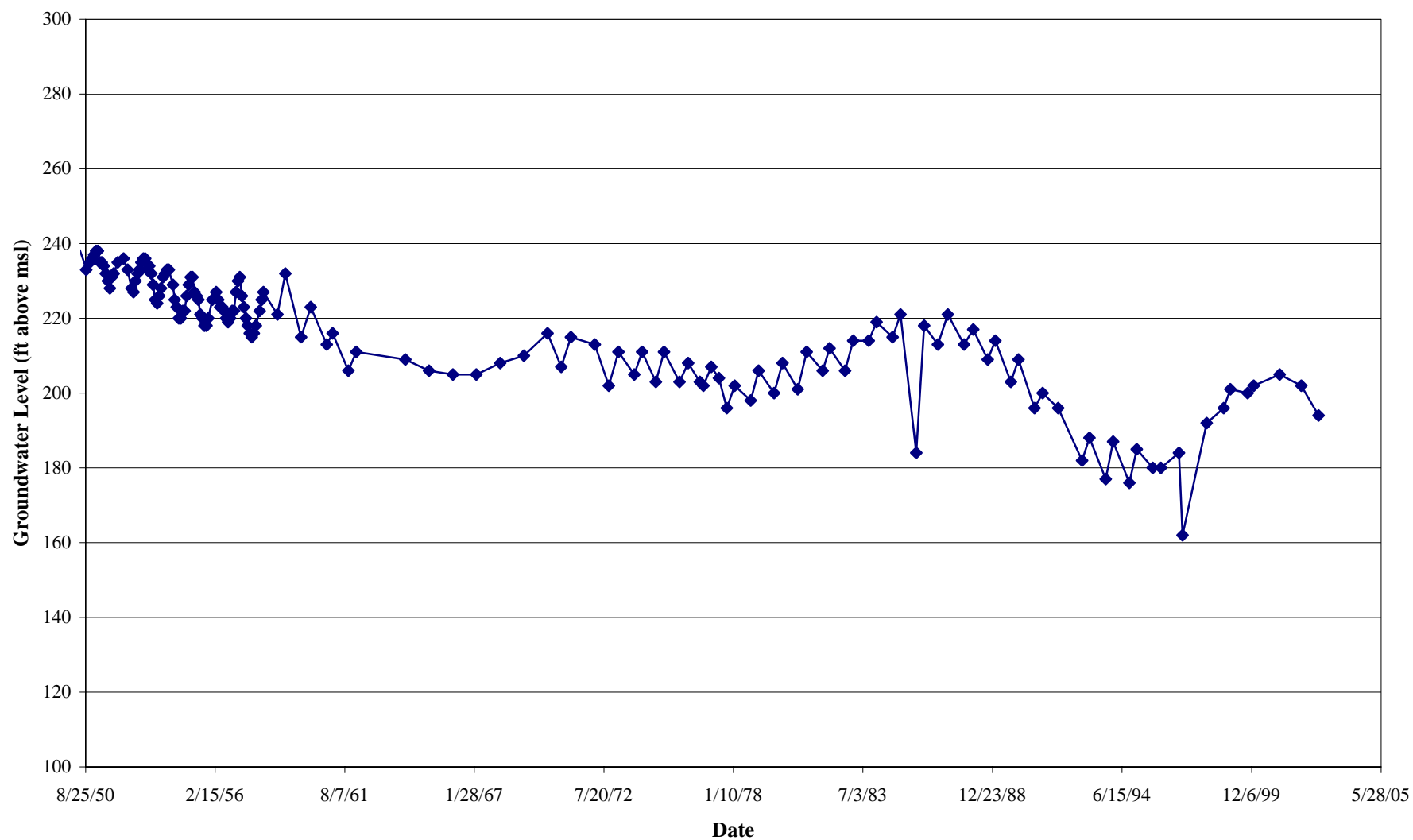


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 17S20E01C001M in WMA B2

FIGURE D.21

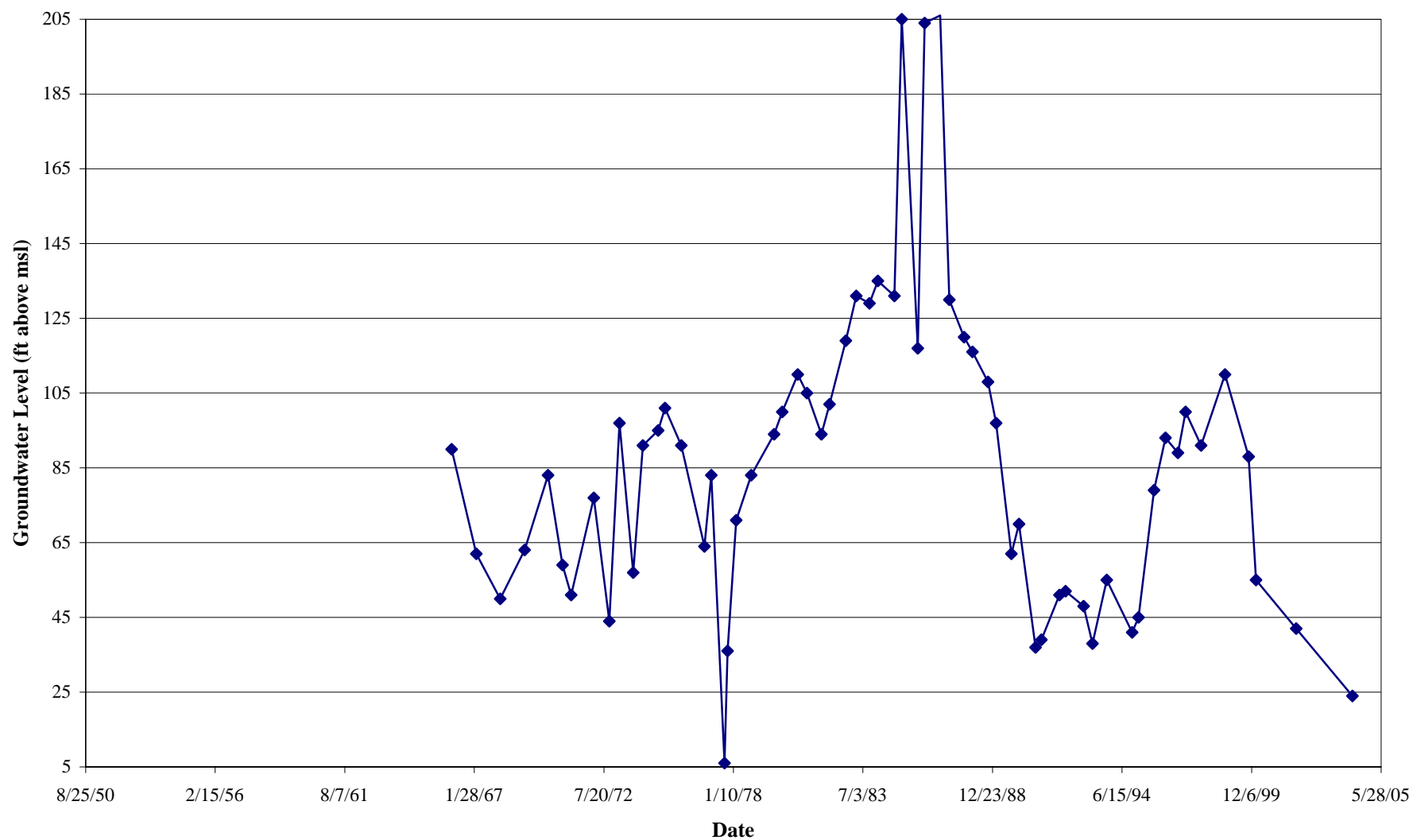


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 17S21E03C001M in WMA B2

FIGURE D.22

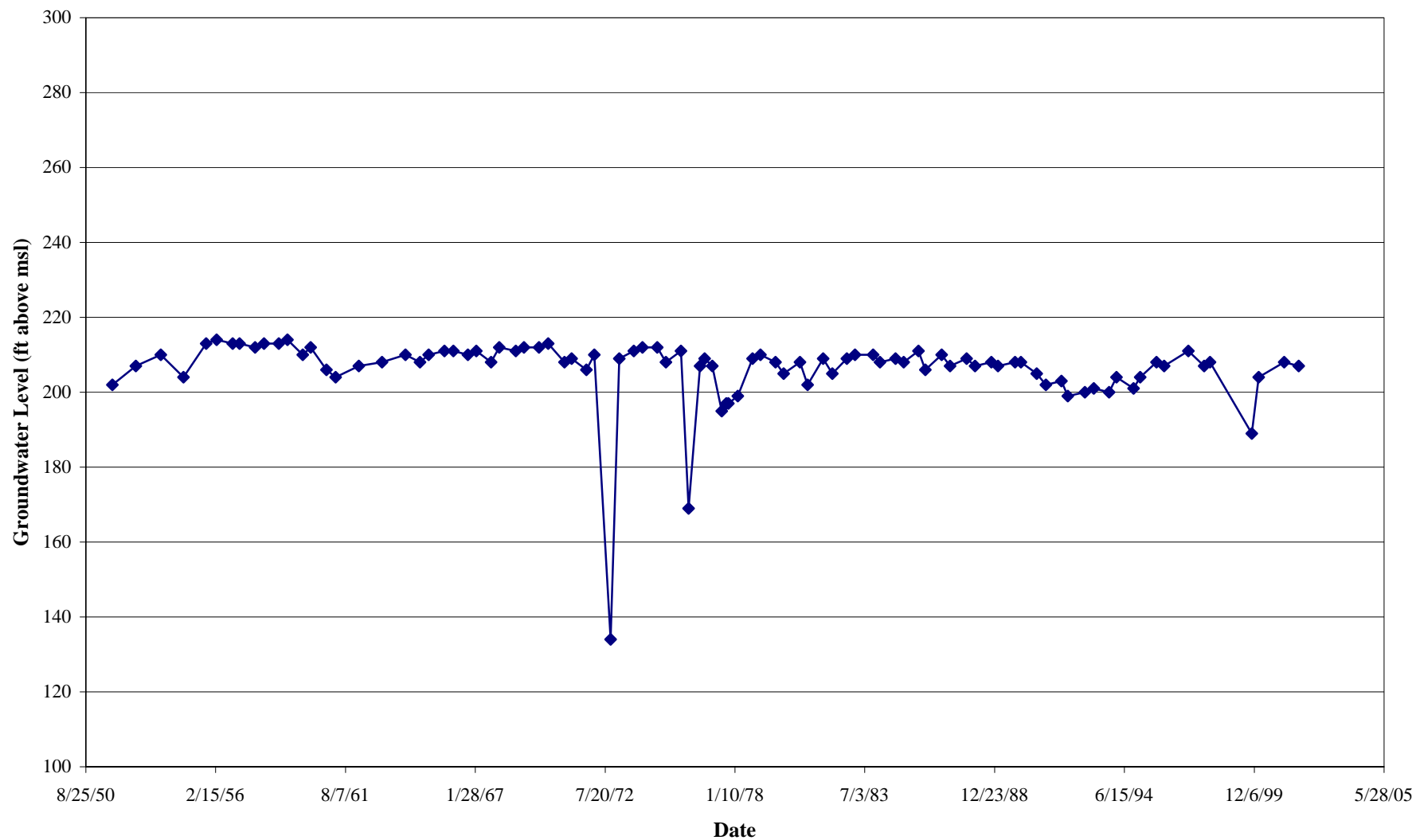


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 18S19E35J002M in WMA C

FIGURE D.23

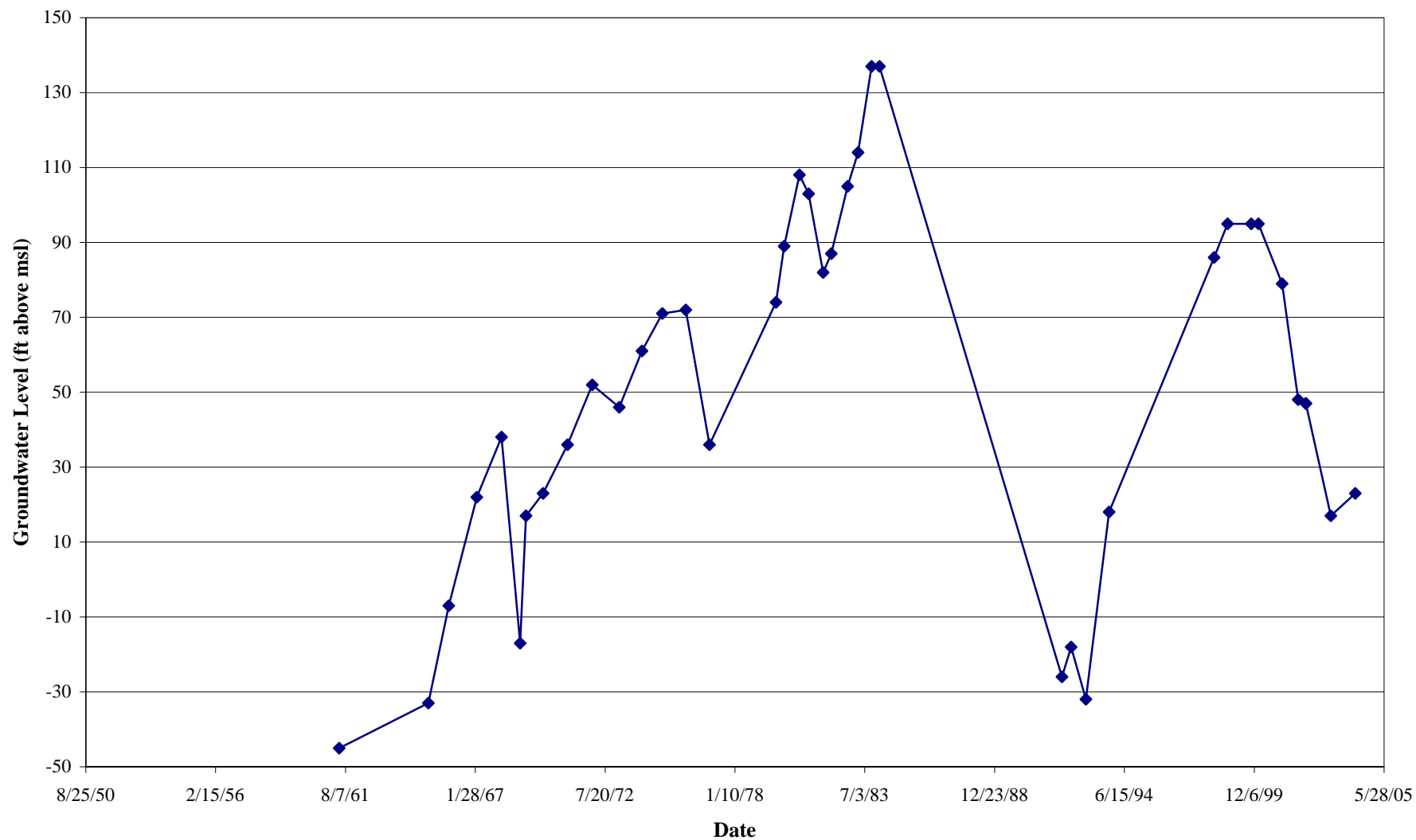


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 19S20E22C001M in WMA C

FIGURE D.24

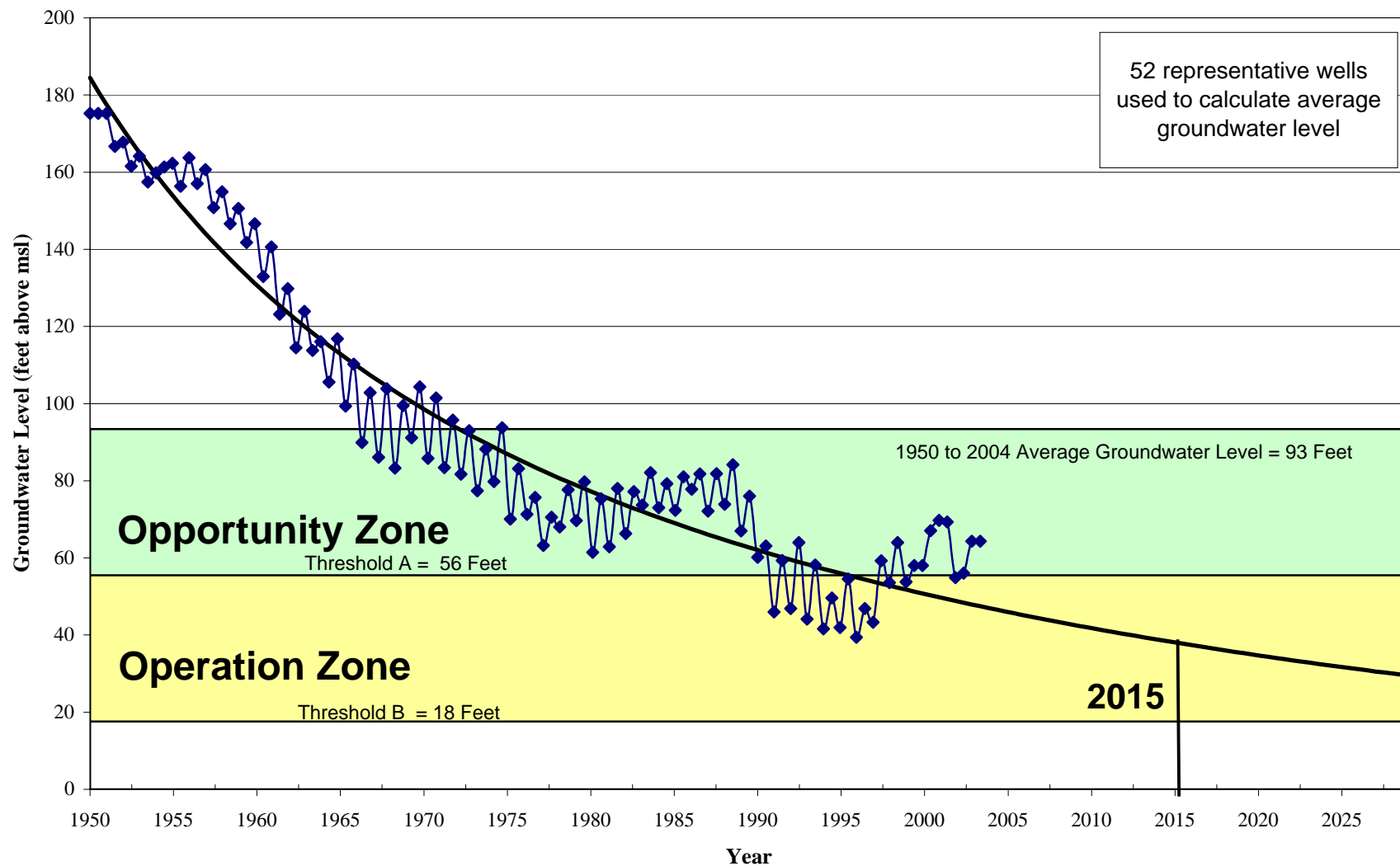


Lower Kings Basin GWMP Update

April 2005

Groundwater Hydrograph for Well 20S20E07H001M in WMA C1

FIGURE D.25

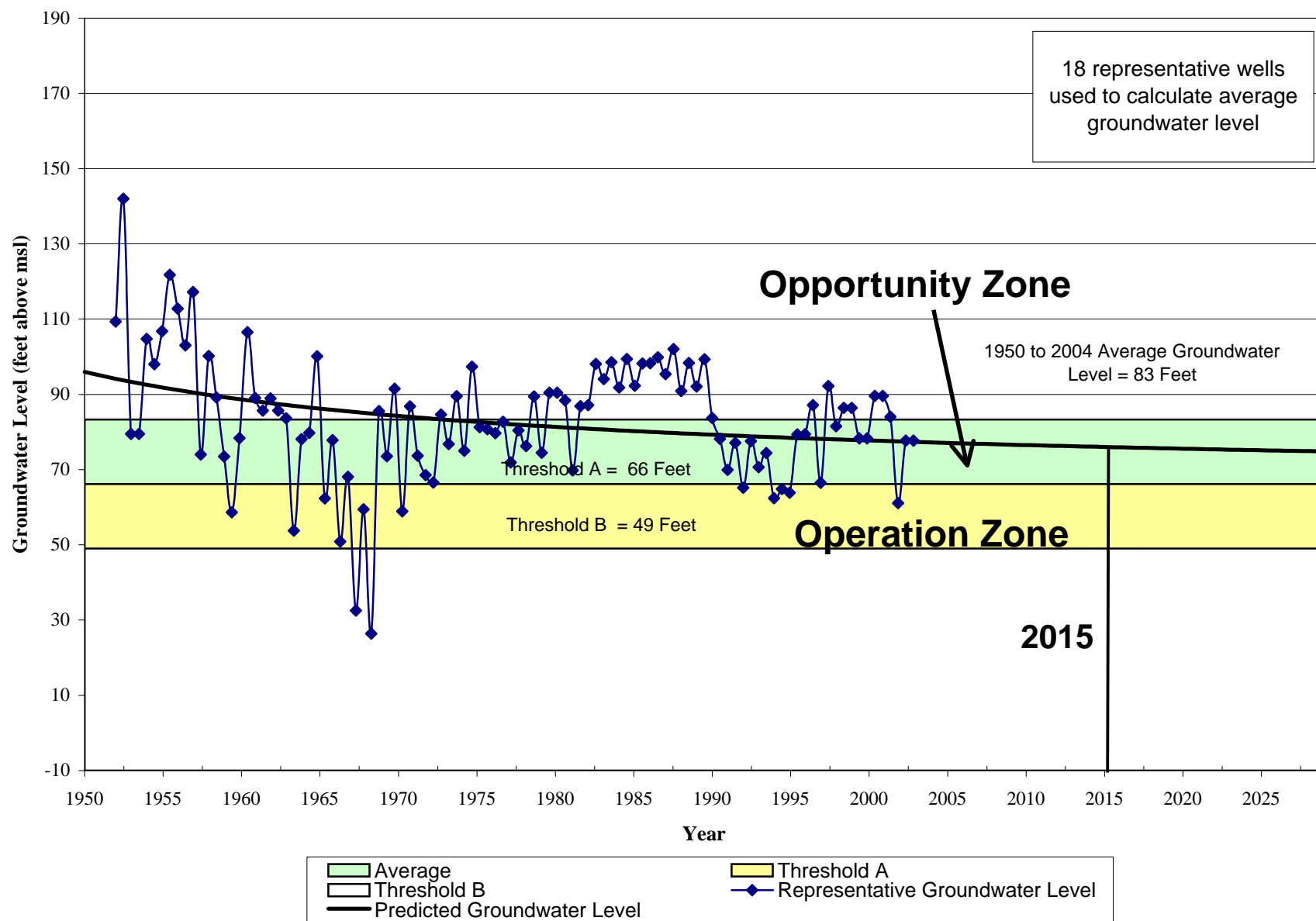


Lower Kings Basin GWMP Update

Groundwater Trends for WMA A

April 2005

FIGURE D.26

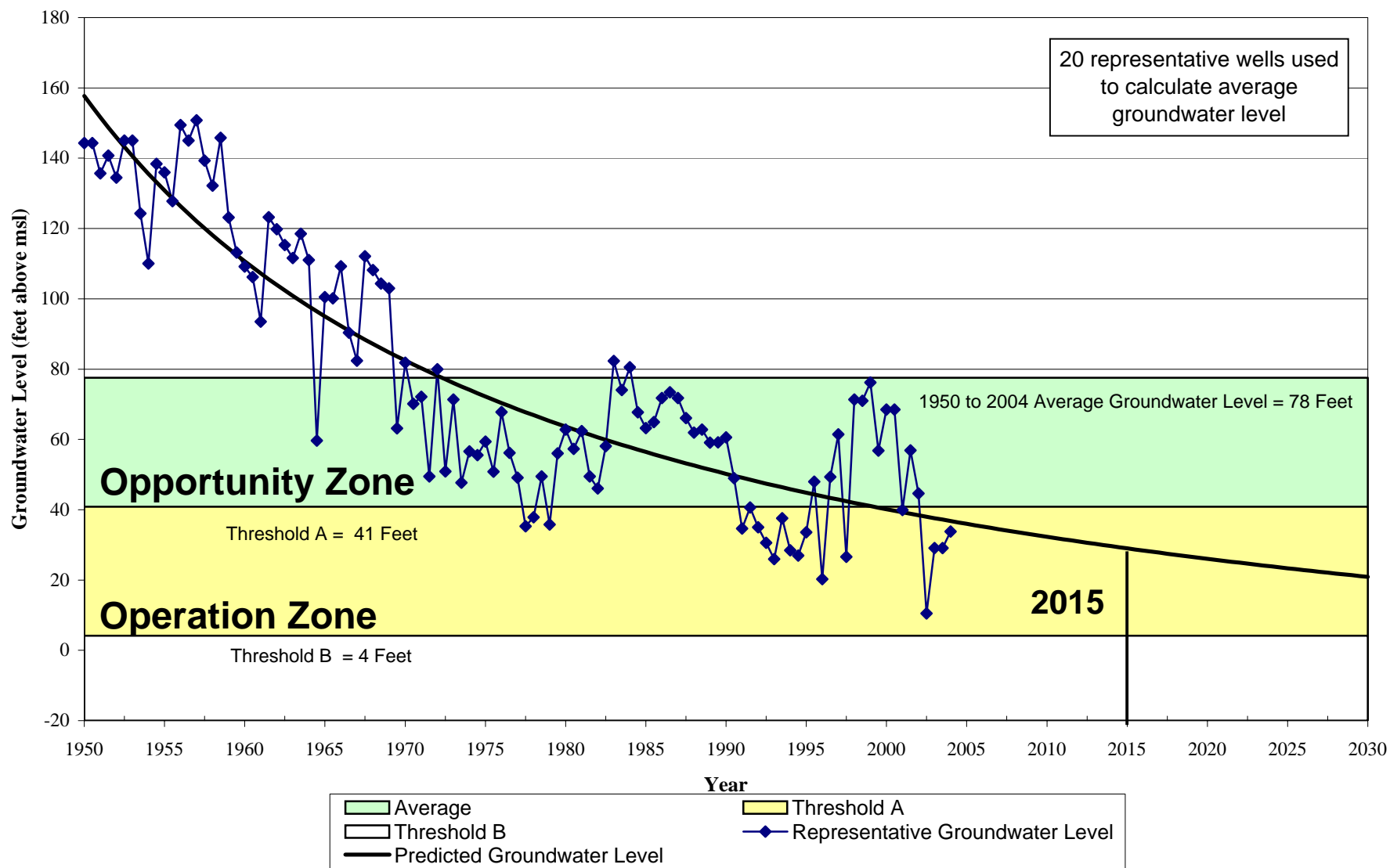


Lower Kings Basin GWMP Update

Groundwater Trends for WMA A1

April 2005

FIGURE D.27

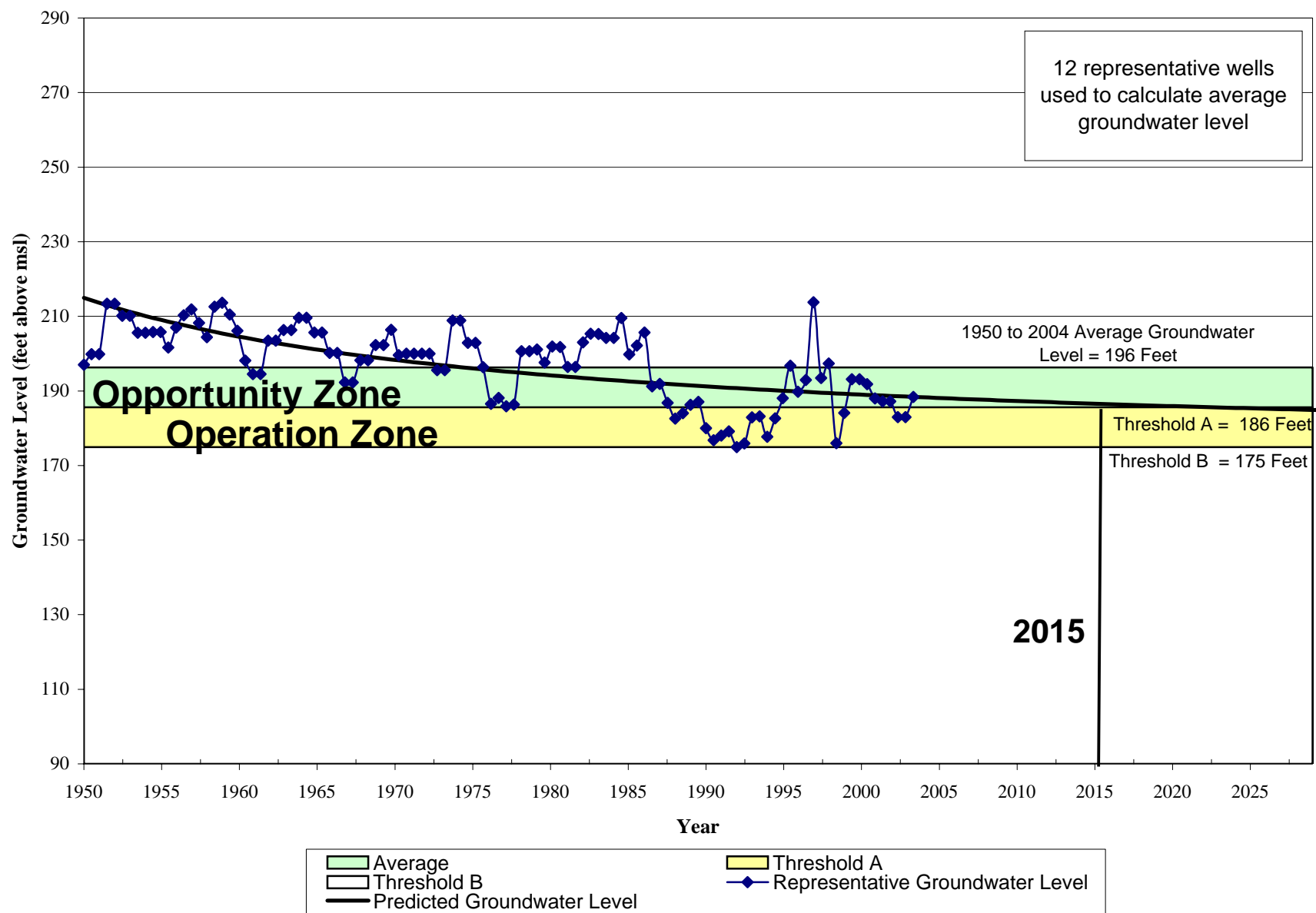


Lower Kings Basin GWMP Update

Groundwater Trends for WMA B

April 2005

FIGURE D.28

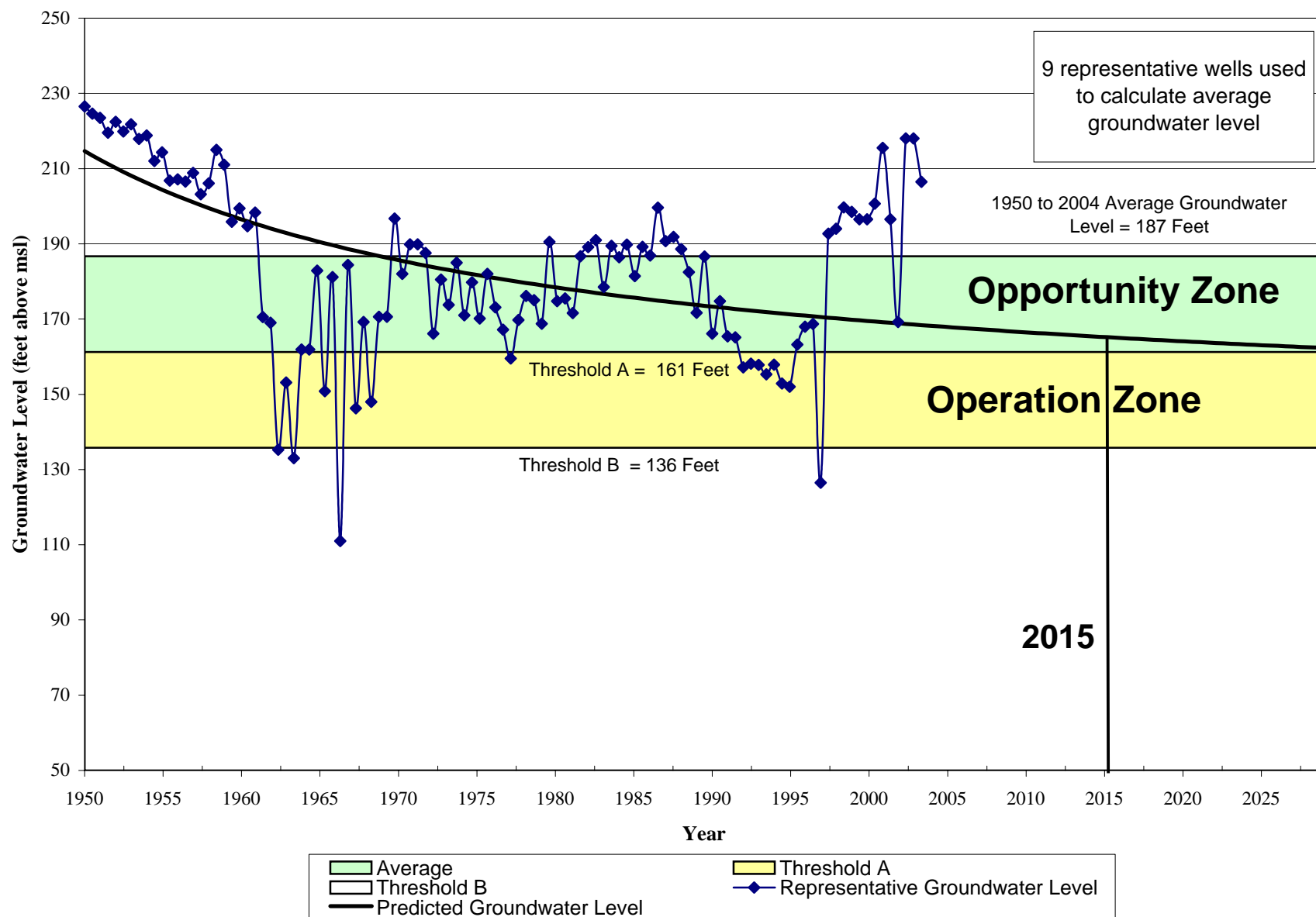


Lower Kings Basin GWMP Update

Groundwater Trends for WMA B1

April 2005

FIGURE D.29

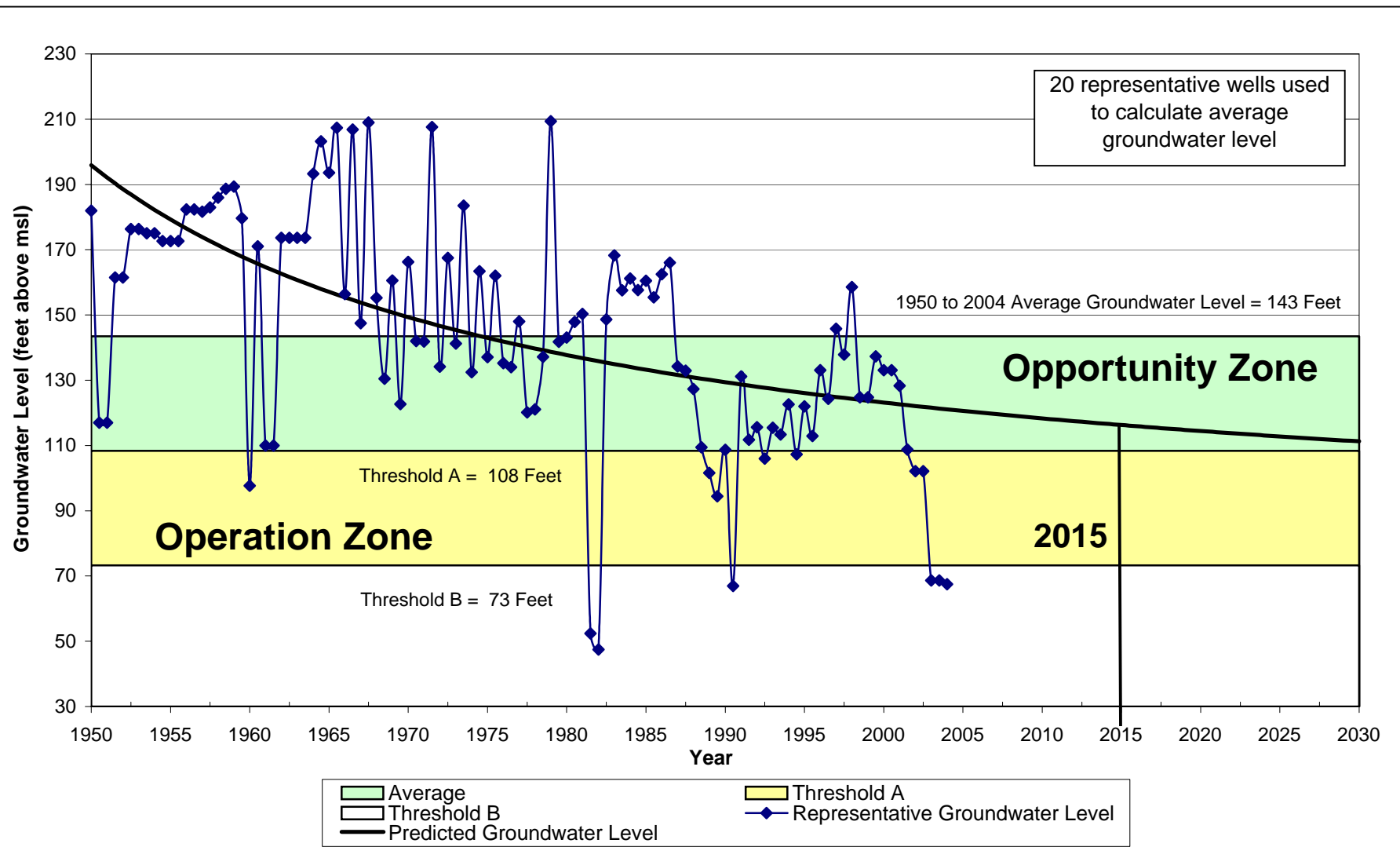


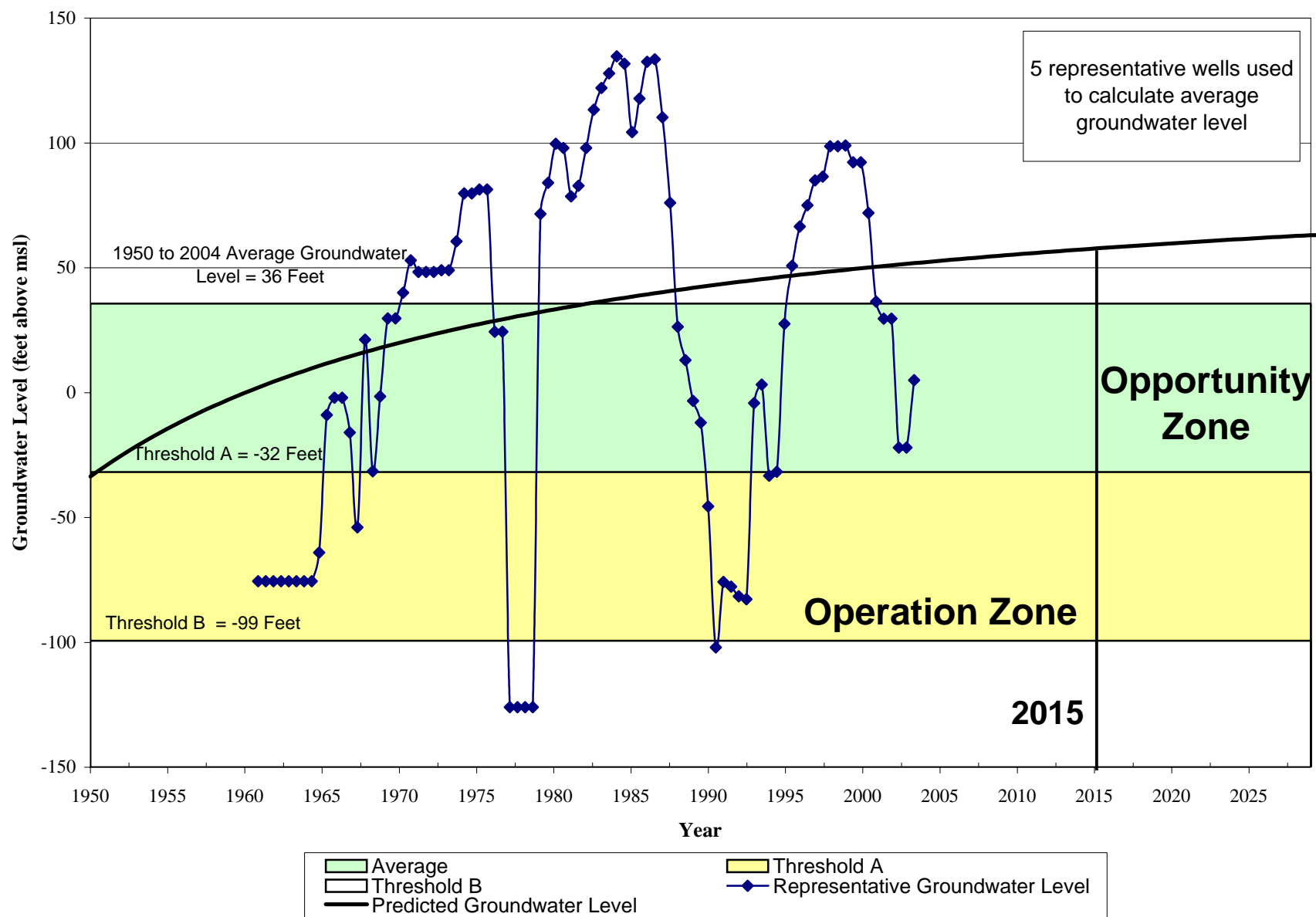
Lower Kings Basin GWMP Update

Groundwater Trends for WMA B2

April 2005

FIGURE D.30



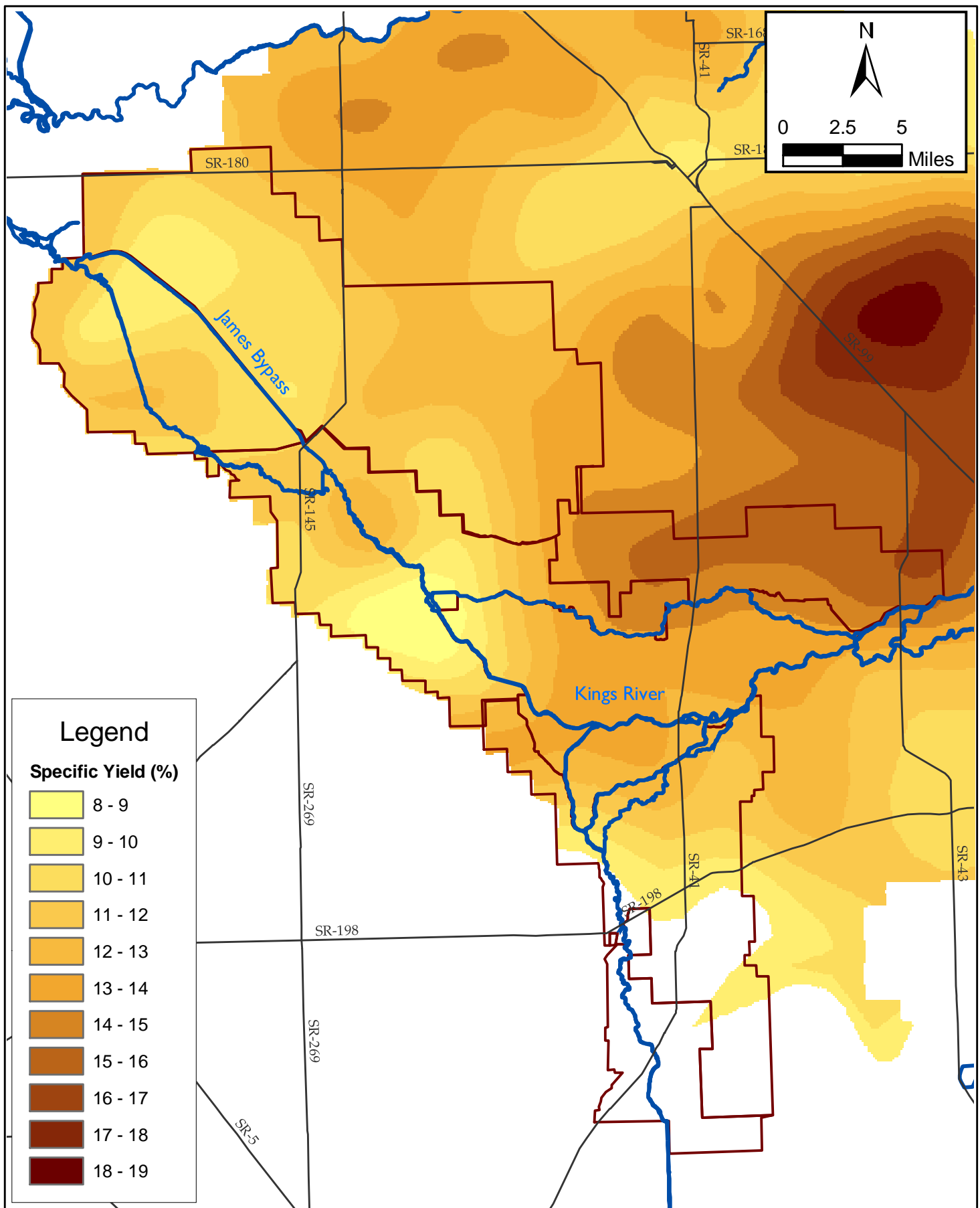


Lower Kings Basin GWMP Update

Groundwater Trends for WMA C1

April 2005

FIGURE D.32



Lower Kings Basin GWMP Update

**Distribution of Specific Yield in
Lower Kings Basin**

April 2005

Figure D.33

E.1 SURFACE WATER AVAILABILITY

The purpose of this analysis was to determine if: 1) there is surface water available from the Kings River for groundwater recharge, 2) if existing facilities have sufficient diversion capacity, and 3) if there is available water, do Lower Kings Basin KWRA member have sufficient entitlement. The process to evaluate surface water conditions included:

1. Obtaining stream flow at James Bypass, headgate diversion, canal capacity, and entitlement data;
2. Sorting and ranking entitlement and diversion data; and
3. Evaluating data for the 1964 through present and only for flood periods only.

It can be concluded for the analysis that there is additional water available to divert from the Kings River in the Lower Kings Basin. Diversions during flood release periods are less than entitlements amounts at the head gates and quite often, less than the design capacity of the canal. This indicates that water is available for diversion during flood period using available canal capacity and under existing entitlement.

E.2 BACKGROUND

The Kings River flows are measured several along the Kings River. The Pine Flat Dam gage (KFG) streamflows are shown on Figure E.1 for the 1945 to 2000 period and demonstrate the hydrologic variability of the basin (CDEC, 2004). The annual KFG flow ranges from a minimum of 359 thousand acre-feet (TAF) in 1977 to a maximum of 4.476 TAF in 1983 and with an average of 1,730 TAF. KFG flows within 25% of the 1945-2000 (long-term) average KFG flow are considered normal year flows. Years with flows exceeding the long-term average by more than 25% are considered wet. Years with flows falling below the long-term average by more than 25% are considered dry. Based on this classification, there are 15 years that can be classified as normal, 14 years that can be classified as wet and 27 years that can be classified as dry. All years considered wet have occurred since 1964.

E.3 KINGS RIVER SURFACE WATER SUPPLY SYSTEM

PINE FLAT RESERVOIR

Pine Flat Reservoir is the primary control of the Kings River. The US Army Corps of Engineers operates the reservoir during flood release periods and the Kings River Water Association operates the reservoir for conservation releases. Kings River is operated in accordance with the terms and conditions of water rights and entitlements, the provisions of State Water Resources Control Board Decision 1290, and a series of agreements and water entitlement schedules (referred to as the "Blue Book Agreements"). KRWA determines each member's entitlement to Kings River water, coordinates water orders placed by its members, executes delivery of water at each member's respective points of diversion, and accounts for any water losses or gains during conveyance (KRWA, 2000).

DIVERSION AND CANAL SYSTEM

Figure E.2 shows the weir and head gate locations associated with the principal canals used to divert water from the King River in the Lower Kings Basin. Historical diversion data was used to evaluate water availability. Table E.1 lists the characteristics of canals (and their associated weirs) that are used in diverting water from the Lower King River and on the North Fork of the Kings River (Provost and Pritchard, 2005). These weirs are a subset of the total number of weirs on the Kings River. It should be noted that Laguna ID diverts water from three locations on the Kings River.

Table E.1. Summary of Lower King Basin Canal Characteristics

Canal/Weir Name	Length (ft)	Estimated Capacity (cfs)
Liberty	84,700	60
A Canal (Laguna ID)	16,200	50
Grant (Laguna ID)	63,200	300
Island (Laguna ID)	46,000	100
Murphy Slough	120,900	550
Crescent	88,500	200
Stinson	59,200	120

E.4 ANALYSIS

The purpose of this analysis was to determine the availability of flood water for recharge in the Lower Kings Basin. The streamflow hydrographs at weir locations on the Kings River are shown in Figures E.3 through E.8 include periods of flood releases from Pine Flat Reservoir.

The streamflow hydrograph at James Weir was used in the analysis to determine the amount of food flows that are available for recharge. The streamflow hydrograph for James Weir is shown in Figure E.8. The location of James Weir is shown in Figure E.1. The average annual streamflow at James Weir is 280 cfs which equates to 200 TAF per year (TAF/yr). The flow discharged to the Mendota Pool occurs in short durations and high flow rates. During the flood period release periods, the average flow rate was 2,130 cfs at James Weir.

Streamflow exceedence charts at the different weir locations are shown in Figures E.9 through E.14 (KWRA, 2005). The figures show the probability of stream flow being equal or exceeded. For example, measured streamflow at Peoples Weir (Figure E.9) was equal to or greater than 500 cfs, 50% of the time when flow was observed. Streamflow at Peoples Weir was equal to or greater than 20 cfs approximately 90% of the time. Figure E.15 shows a stream flow exceedence chart for James Weir during flood release periods only. The figure shows that that 55% of daily James Weir flows were greater than 1,500 cfs and 75% of daily James Weir flows were greater than 300 cfs during flood release periods. Streamflow measured at James Weir is represents water that is lost to the Kings Basin. This flood flow, with proper facilities in place, could be used for groundwater recharge purposes.

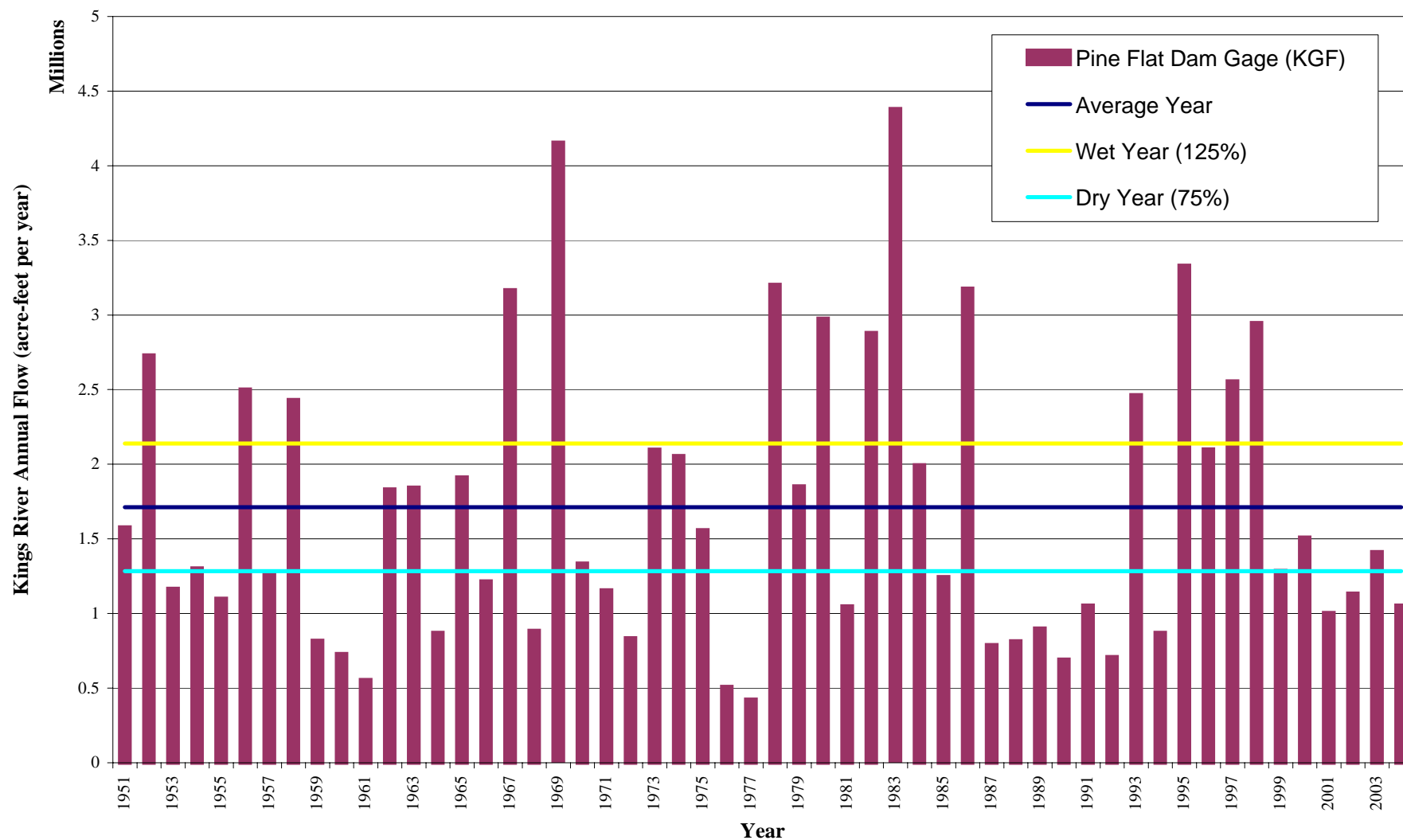
Additional analysis was conducted to determine if additional water could have been diverted during flood conditions using existing structures and entitlements. Diversion and entitlement data were collected for each weir location. Canal capacity data was also obtained. KRWA member entitlements, KWRA member head gate diversion data, and canal capacities are shown at each weir location in Figures E.16 through E.20. Since multiple KRWA members divert water from the same weir and members will divert from multiple weirs, the individual member entitlements have been aggregated into a single value representing the total KWRA member entitlement at the weir. KWRA diversions were aggregated in the same manner.

Figures E.16 through E.20 show monthly data for the 1964 through 2004 period (Provost and Pritchard, 2005). The periods when there were flood releases are indicated, but it is not clear from the figures how much additional water could have been diverted during flood release periods. The following process was followed to determine how much additional water could have been diverted:

1. Monthly data associated flood release months was identified and used for further analysis;
2. The difference between entitlement and diversion amount was calculated; and
3. The difference was ranked and a percent exceedence was determined.

Figures E.21 through E.15 show the results of this analysis for each weir location. It can interpreted from the figures that for at least 70% of the months with flood releases, additional

water could have diverted under existing entitlement and canal capacities. Canal capacities do not limit the available water for diversion until flows rates are 10% exceedence.

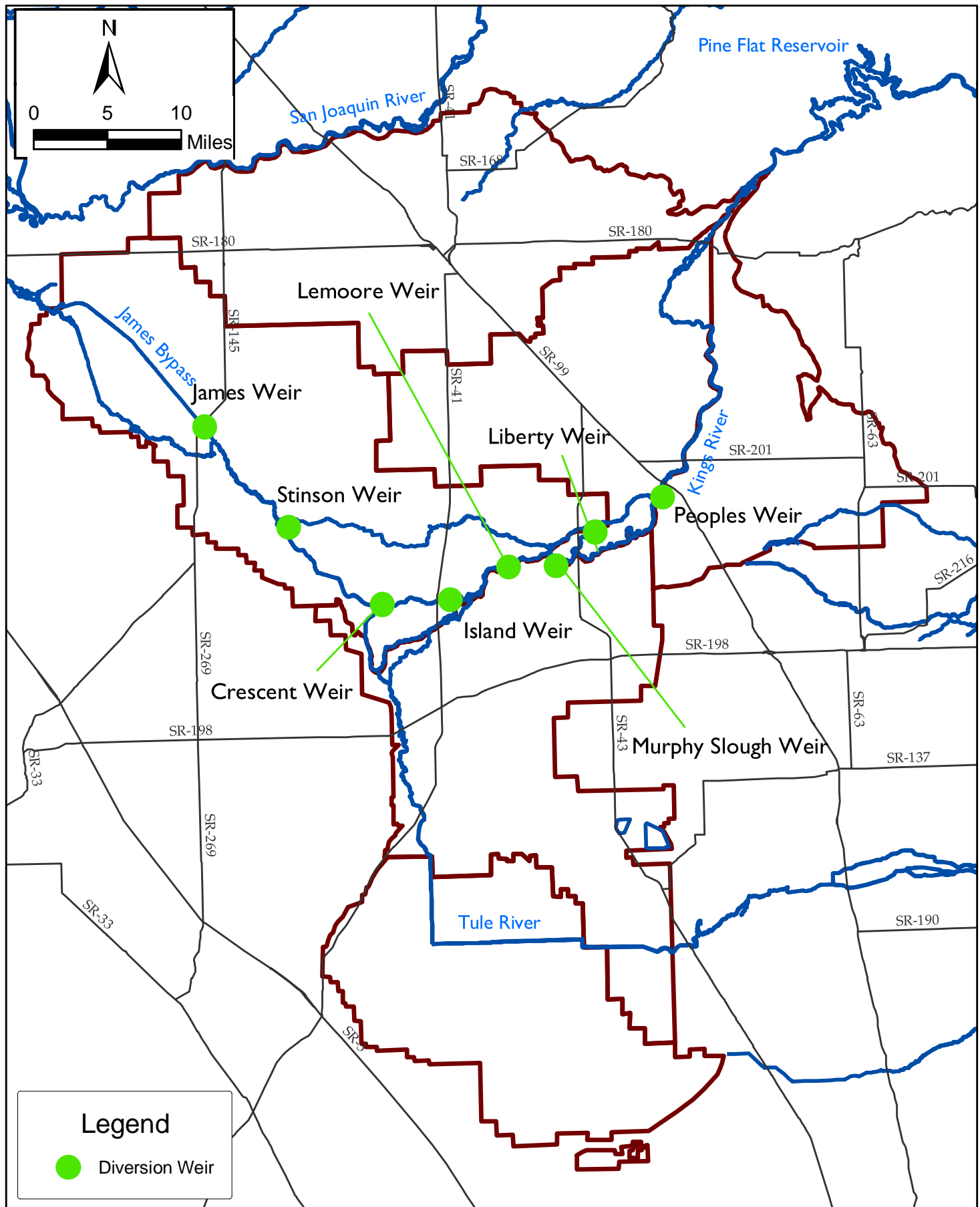


Lower Kings Basin GWMP Update

Kings River Annual Streamflow

April 2005

FIGURE E.1

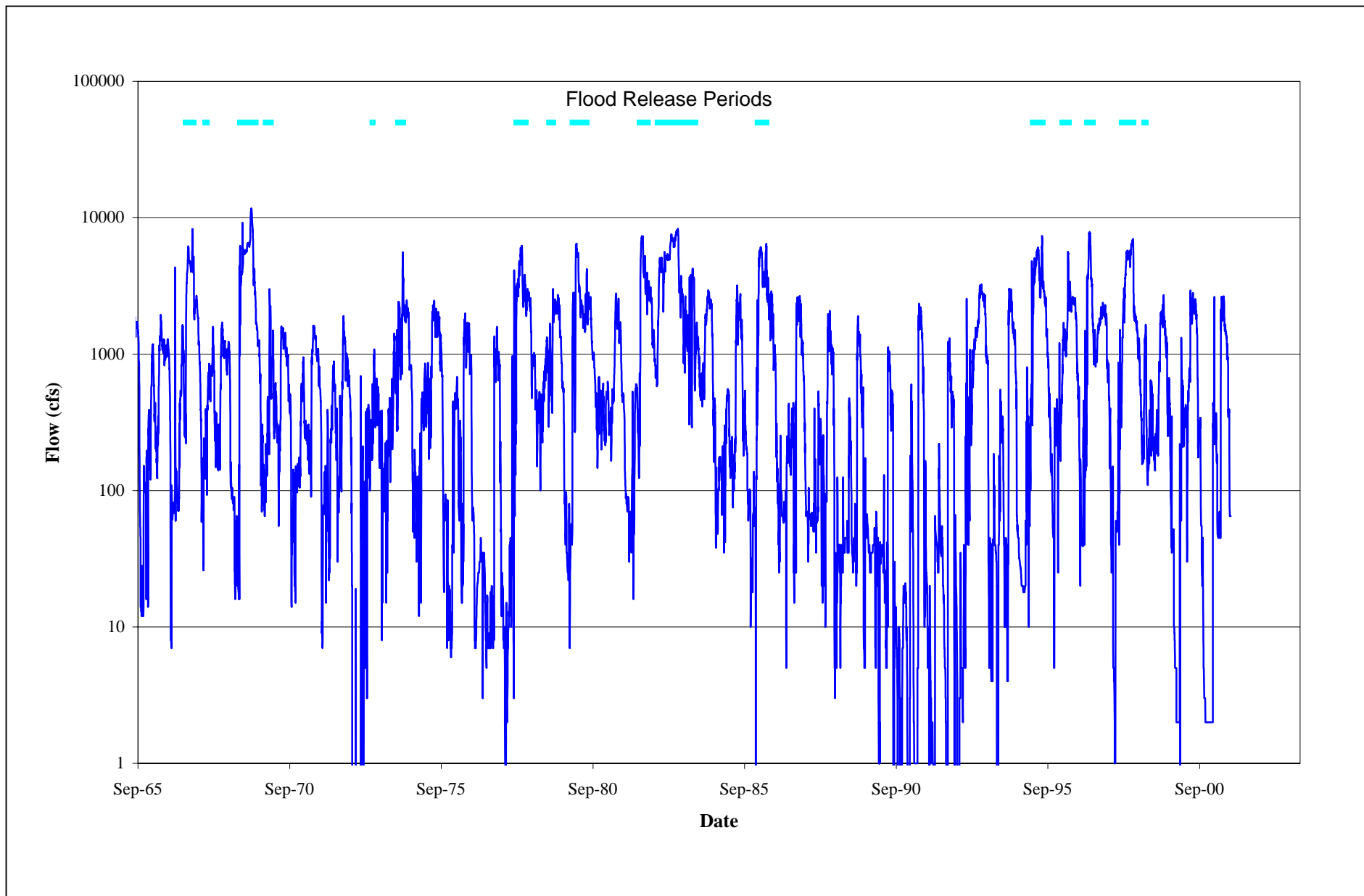


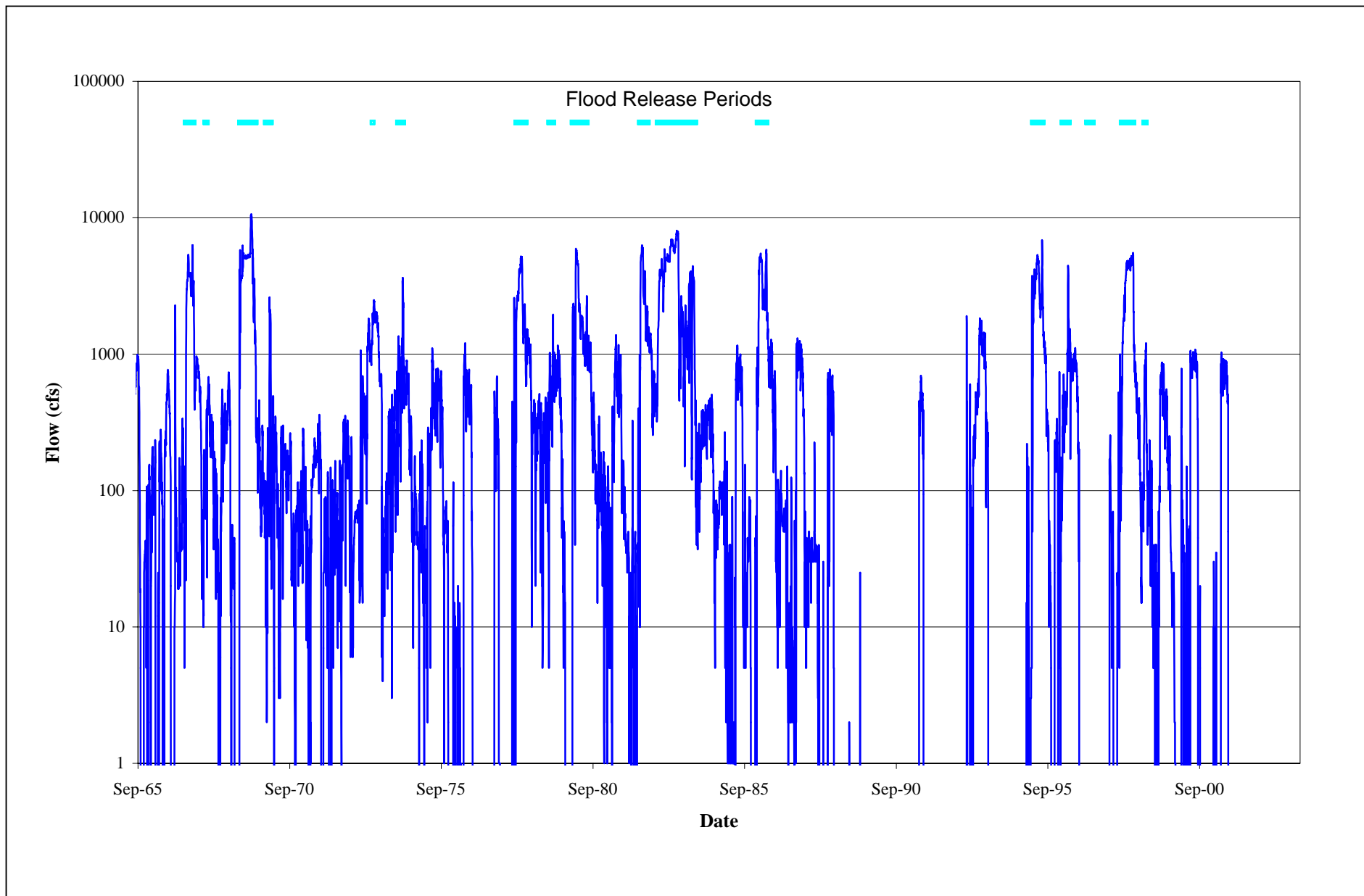
Lower Kings Basin GWMP Update

Diversion Weirs

April 2005

Figure E.2



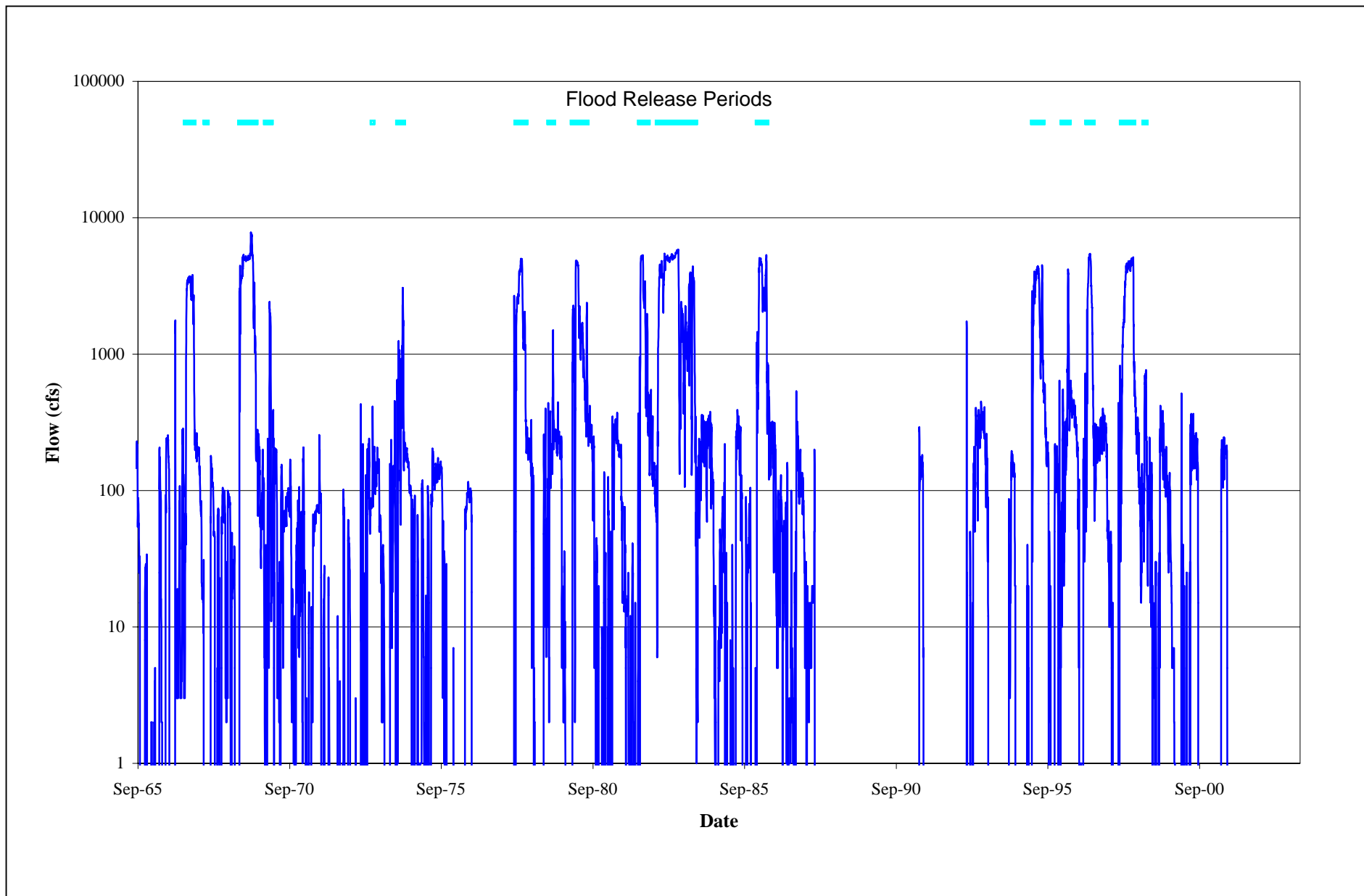


Lower Kings Basin GWMP Update

April 2005

Kings River Flow Below Lemoore Weir

FIGURE E.4

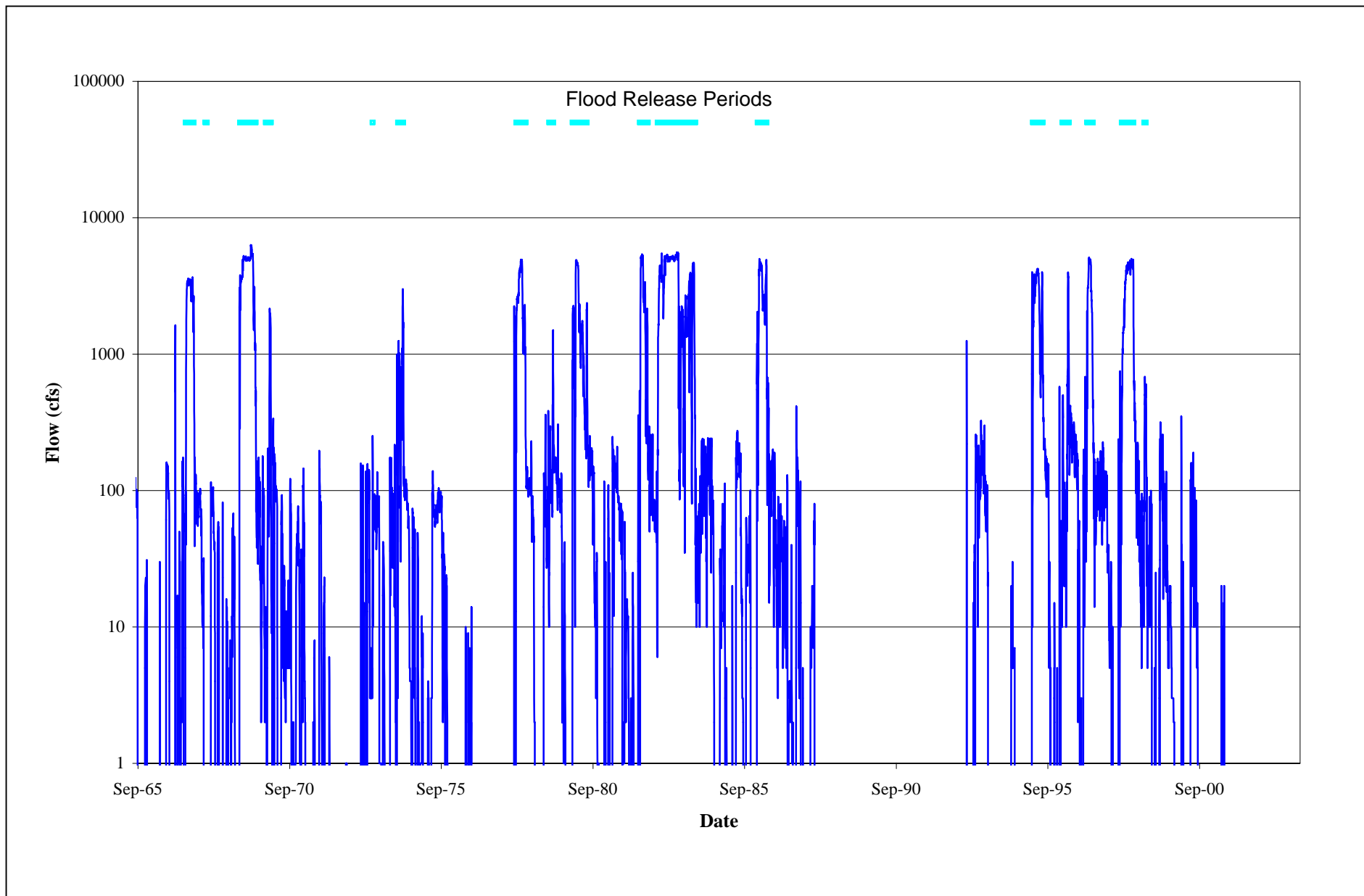


Lower Kings Basin GWMP Update

Kings River Flow Below Island Weir

April 2005

FIGURE E.5

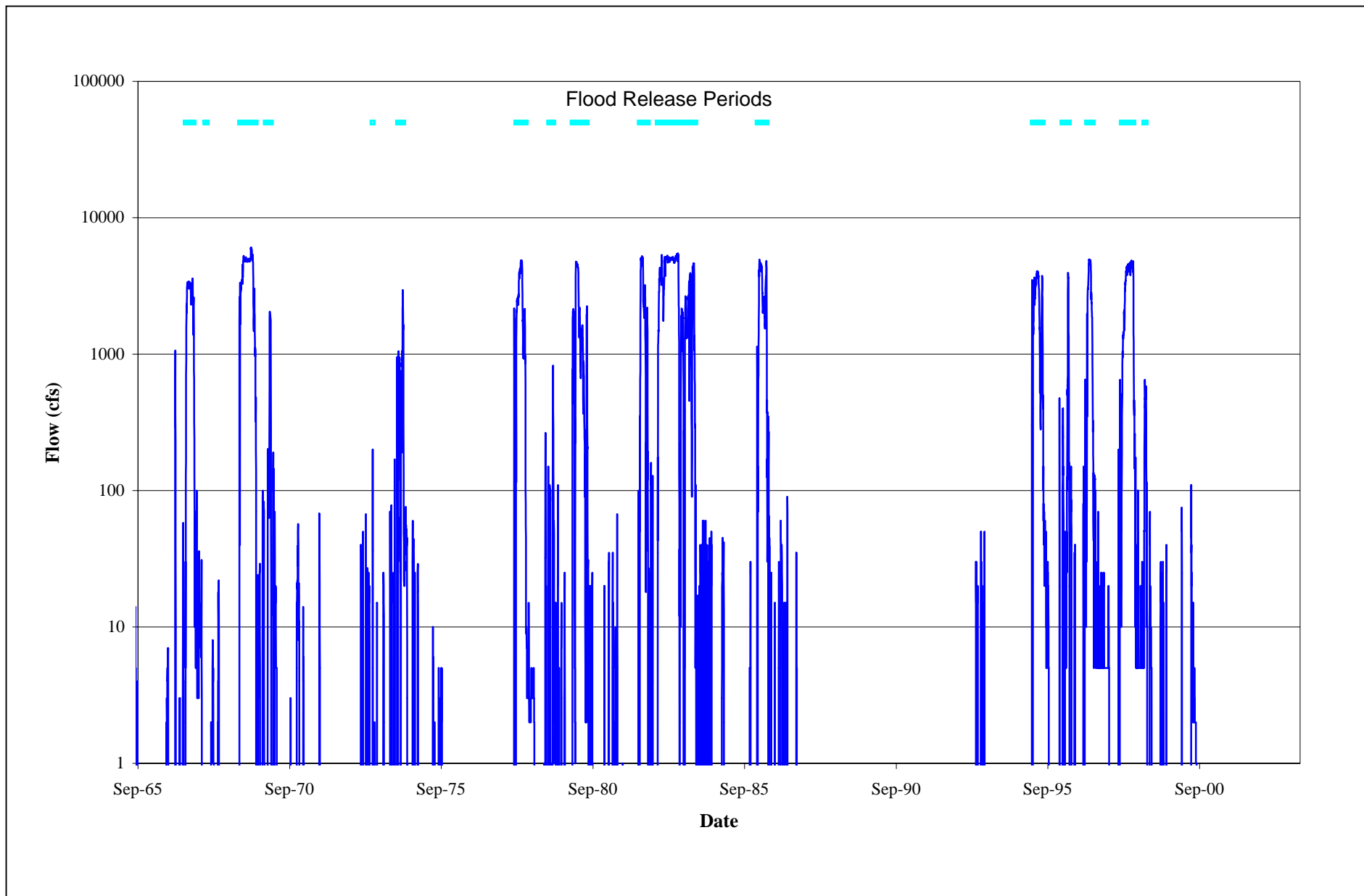


Lower Kings Basin GWMP Update

Kings River Flow Below Crescent Weir

April 2005

FIGURE E.6

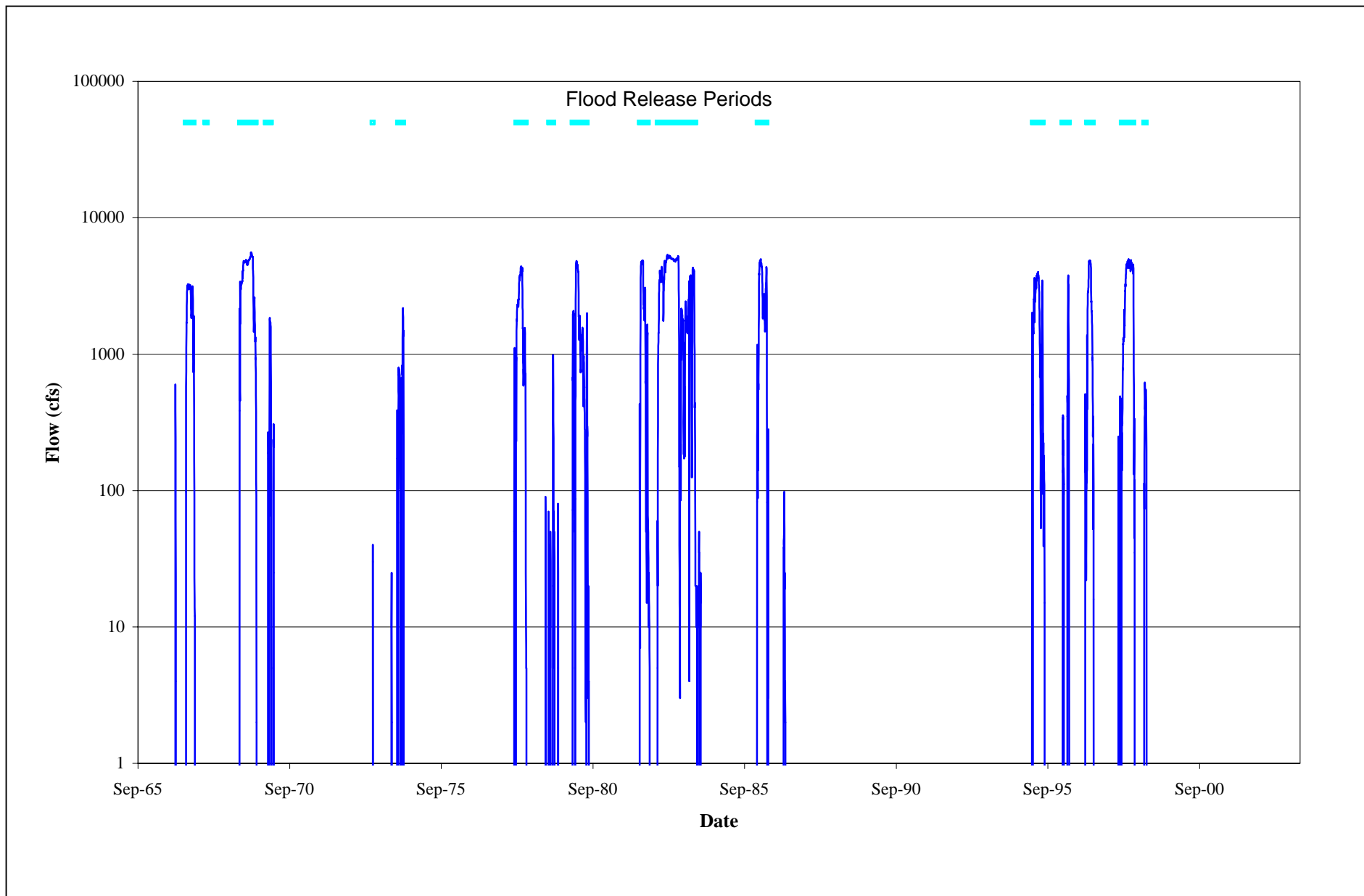


Lower Kings Basin GWMP Update

Kings River Flow Below Stinson Weir

April 2005

FIGURE E.7

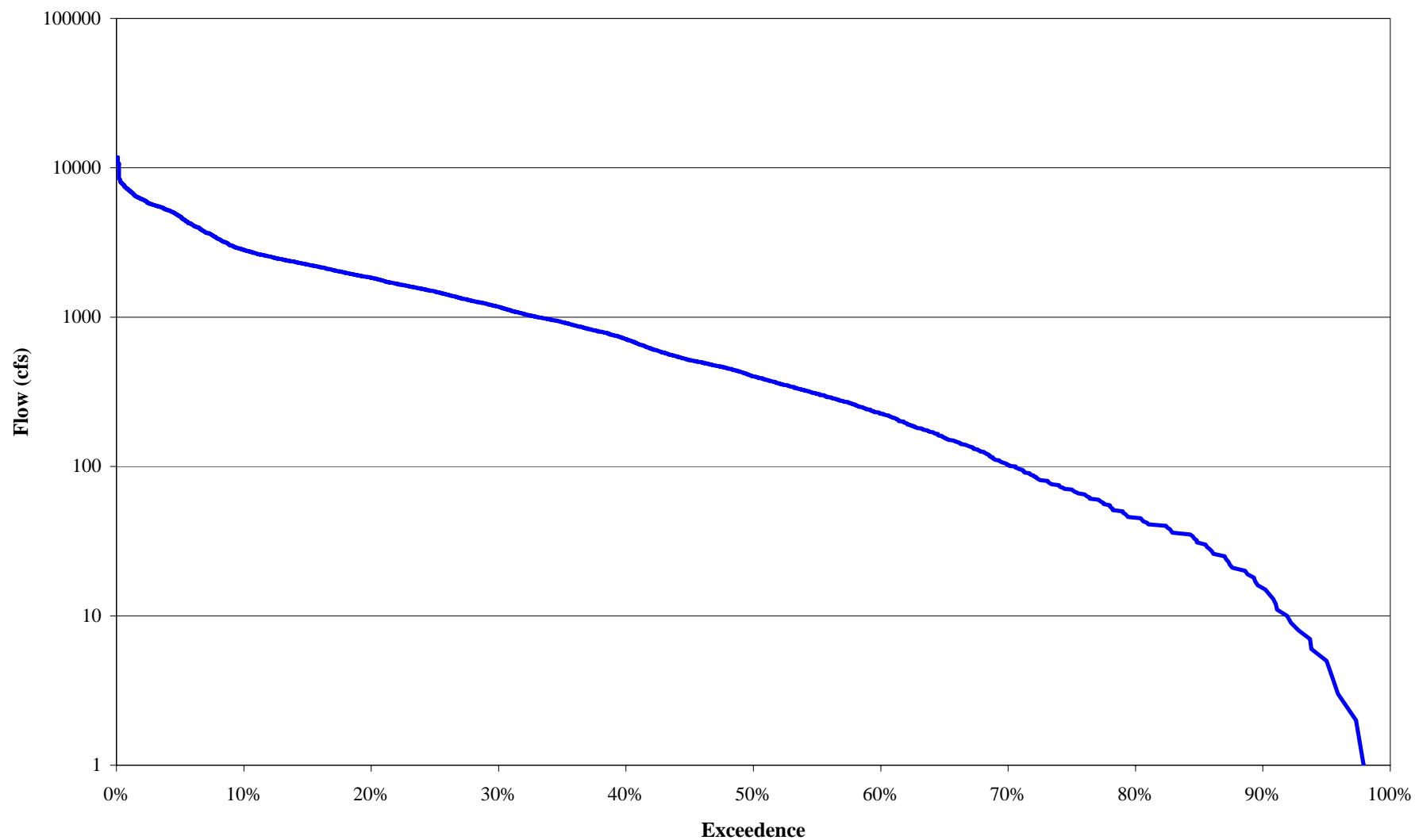


Lower Kings Basin GWMP Update

Kings River Flow Below James Weir

April 2005

FIGURE E.8

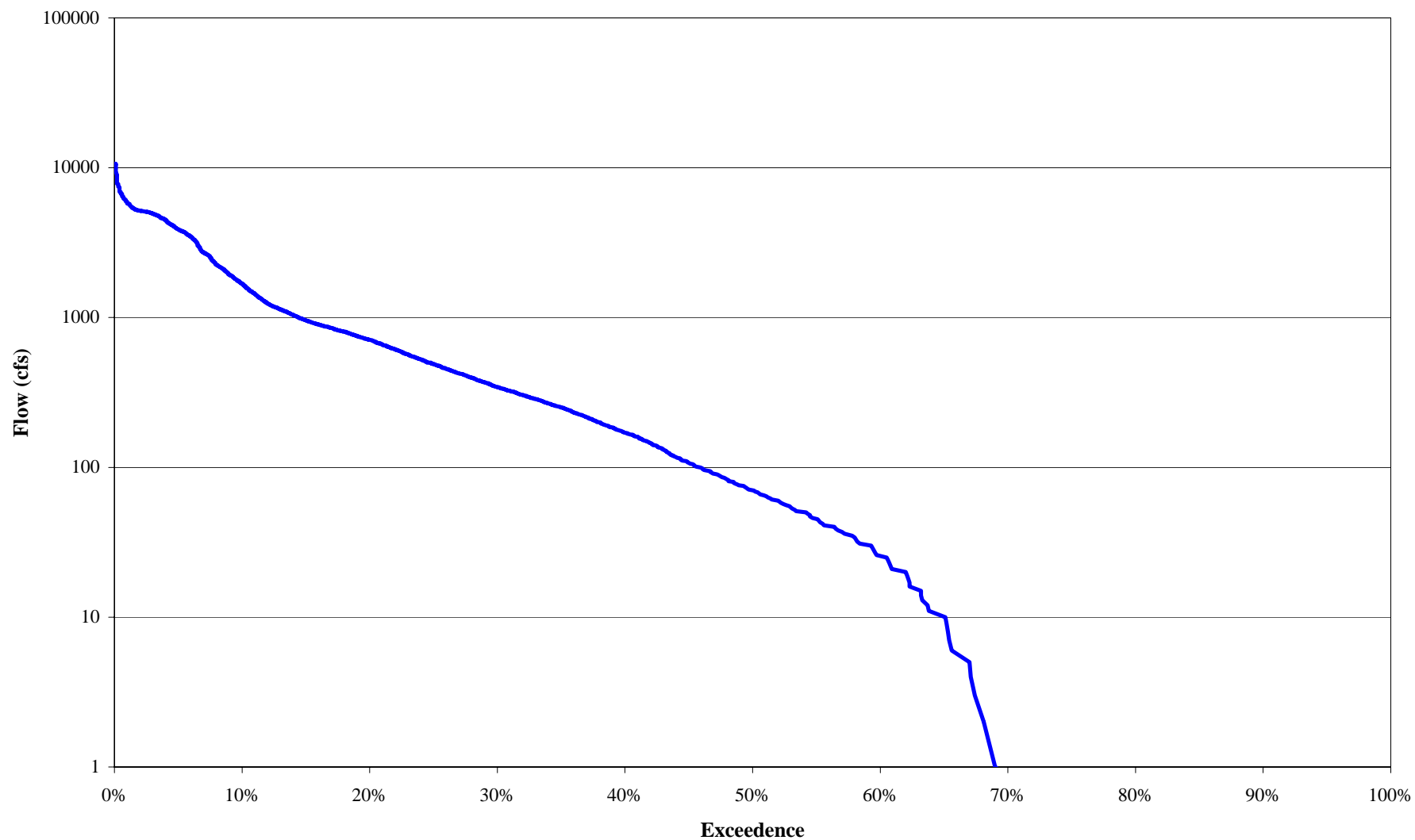


Lower Kings Basin GWMP Update

April 2005

Kings River Exceedence Below Peoples Weir

FIGURE E.9

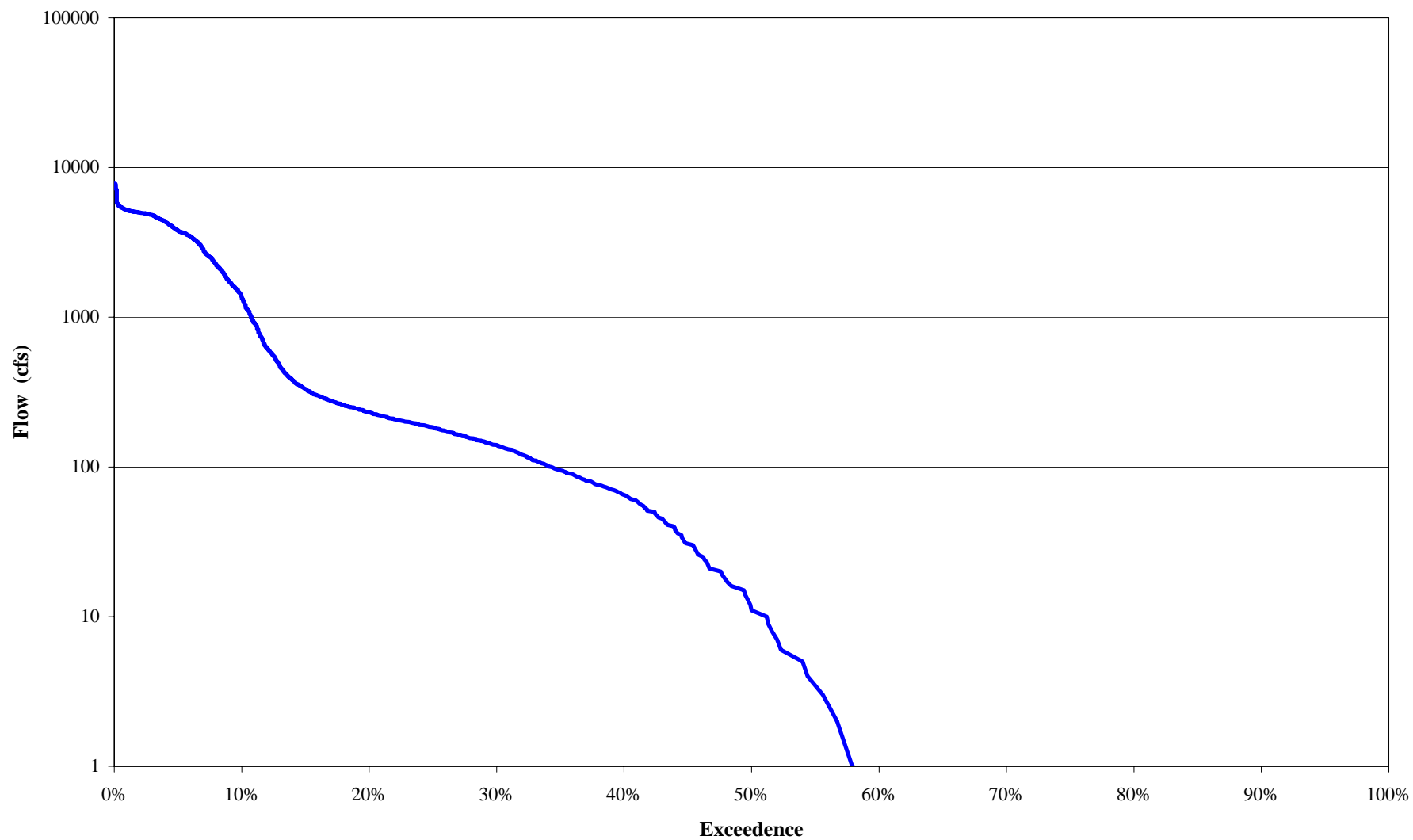


Lower Kings Basin GWMP Update

April 2005

Kings River Exceedence Below Lemoore Weir

FIGURE E.10

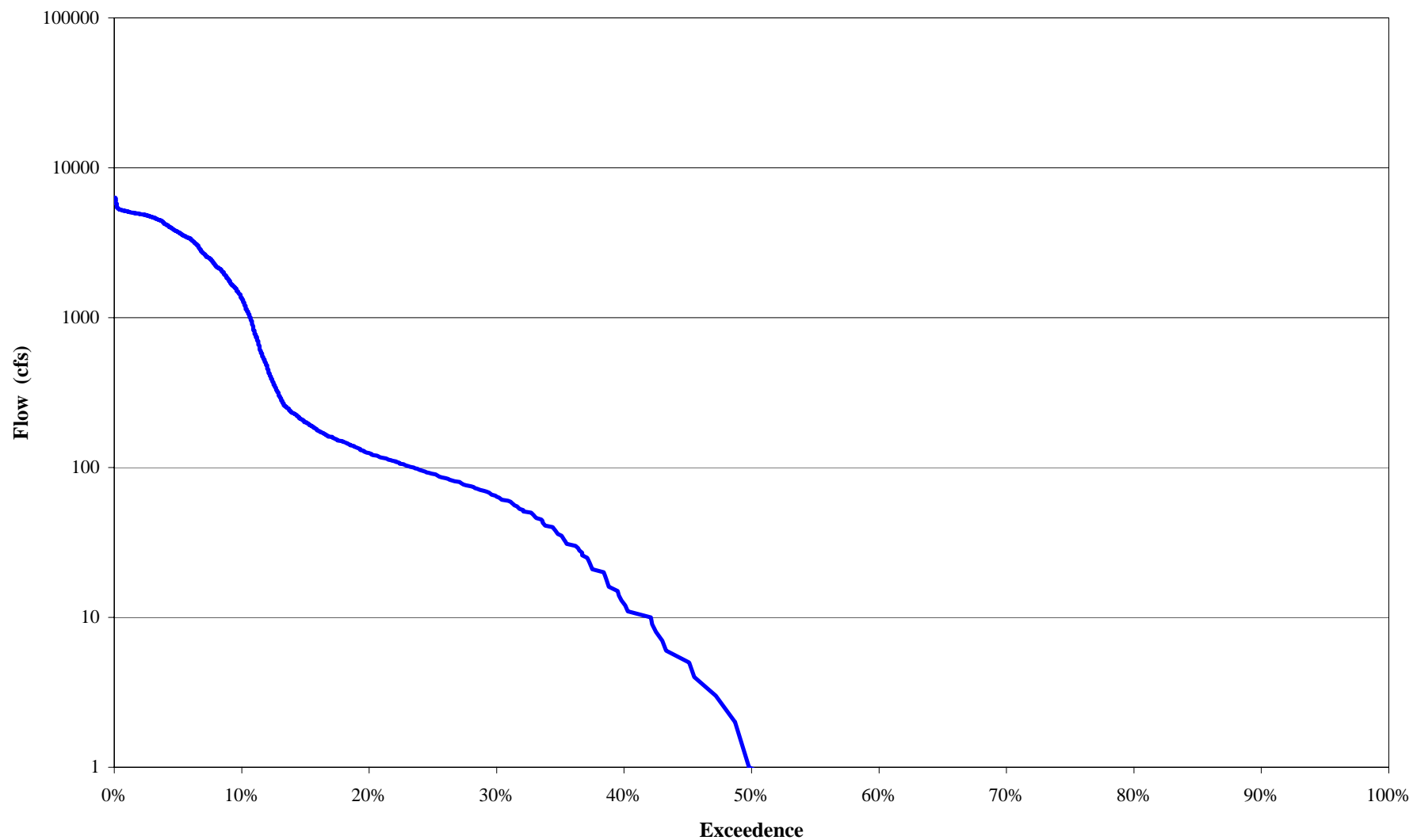


Lower Kings Basin GWMP Update

April 2005

Kings River Exceedence Below Island Weir

FIGURE E.11

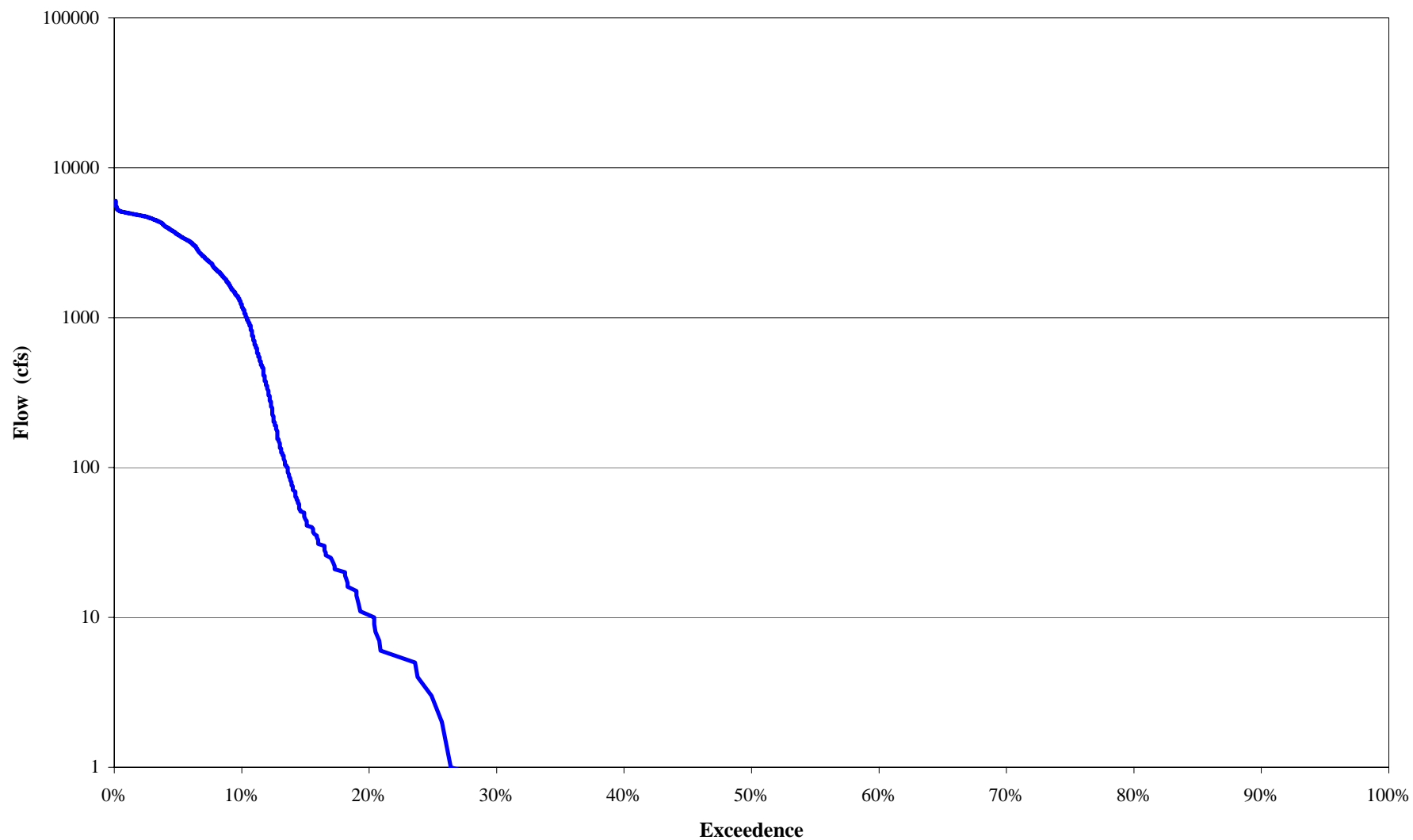


Lower Kings Basin GWMP Update

April 2005

Kings River Exceedence Below Crescent Weir

FIGURE E.12

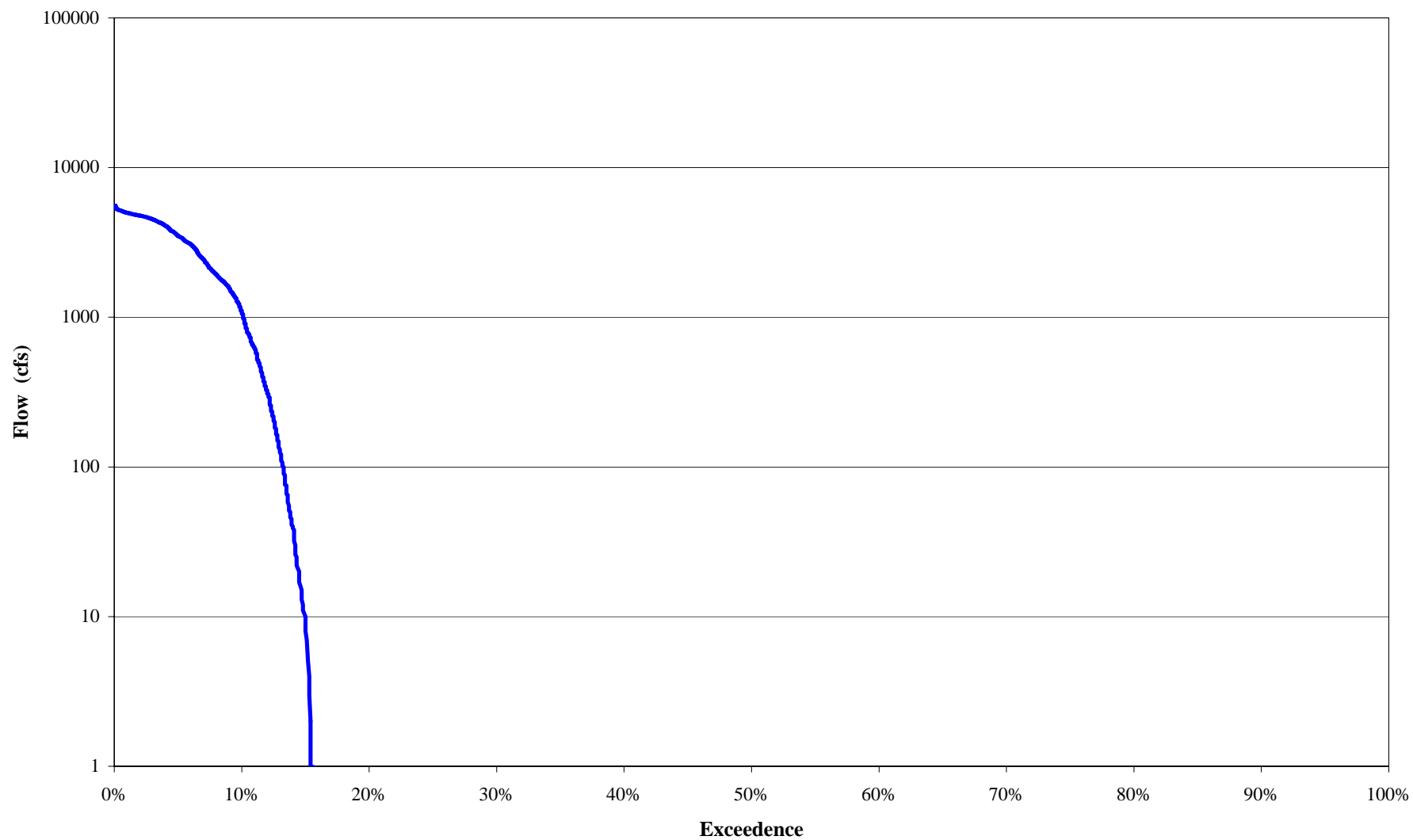


Lower Kings Basin GWMP Update

April 2005

Kings River Exceedence Below Stinson Weir

FIGURE E.13

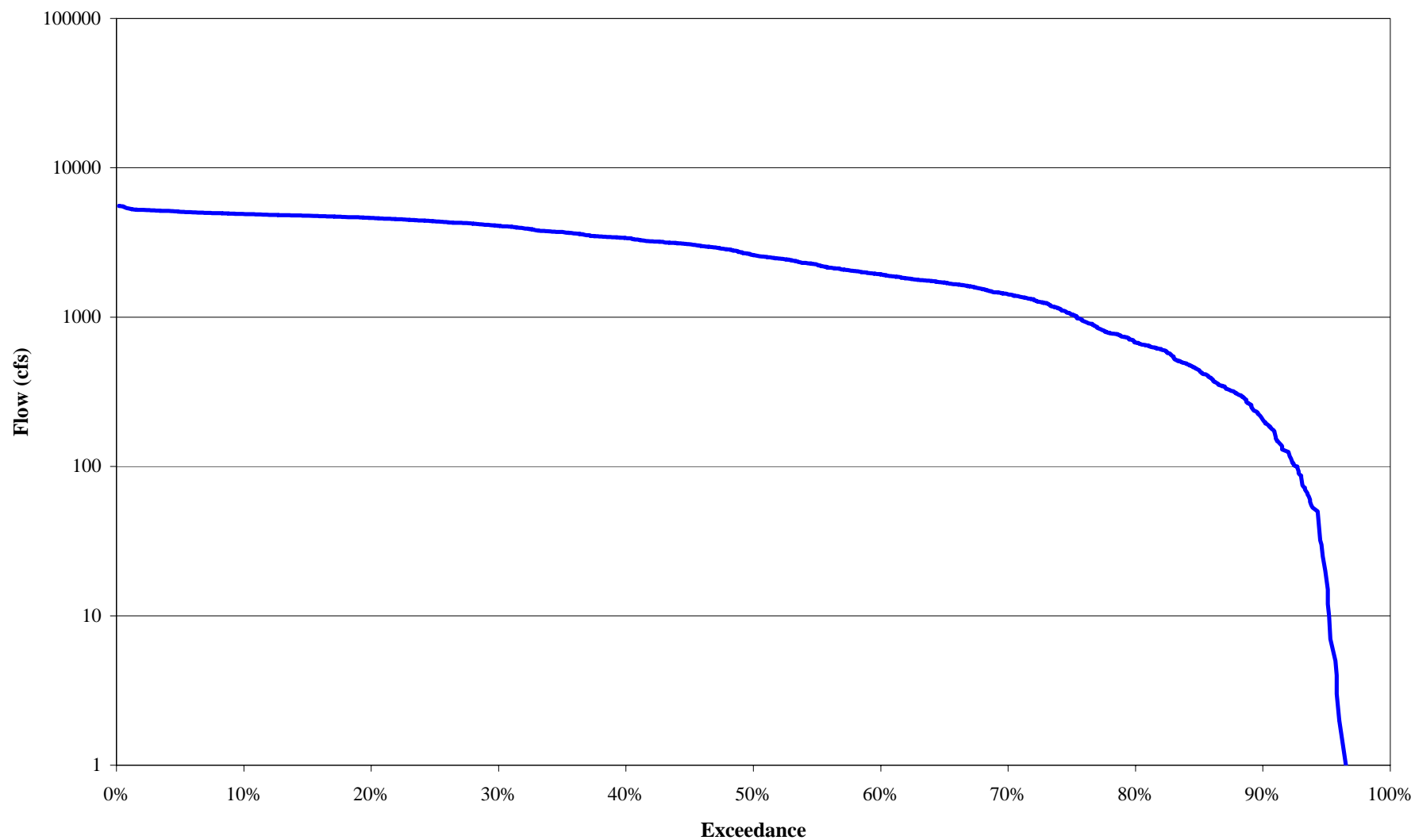


Lower Kings Basin GWMP Update

April 2005

Kings River Exceedence Below James Weir

FIGURE E.14

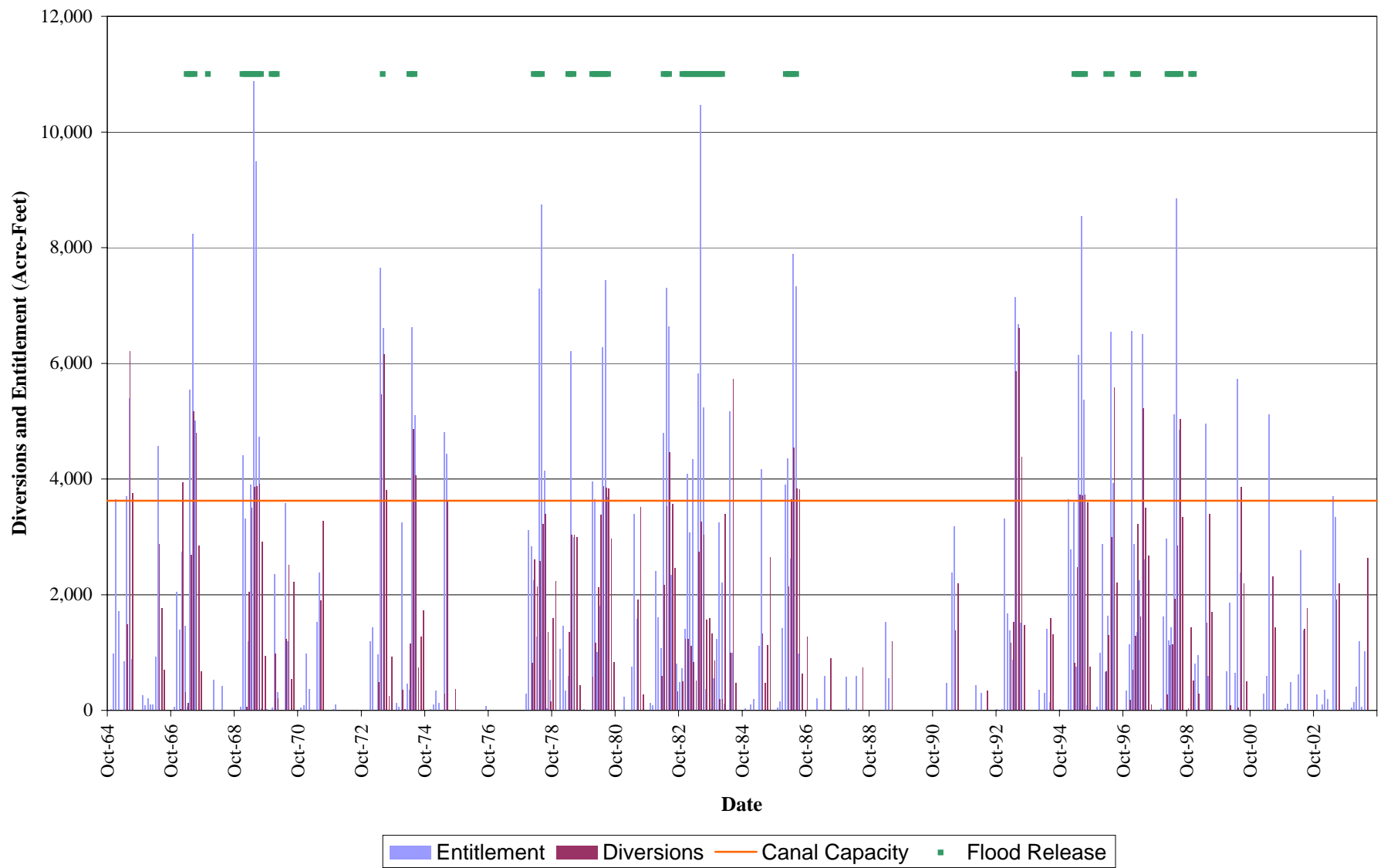


Lower Kings Basin GWMP Update

April 2005

Kings River Exceedance Below James Weir during Flood-Release Periods

FIGURE E.15

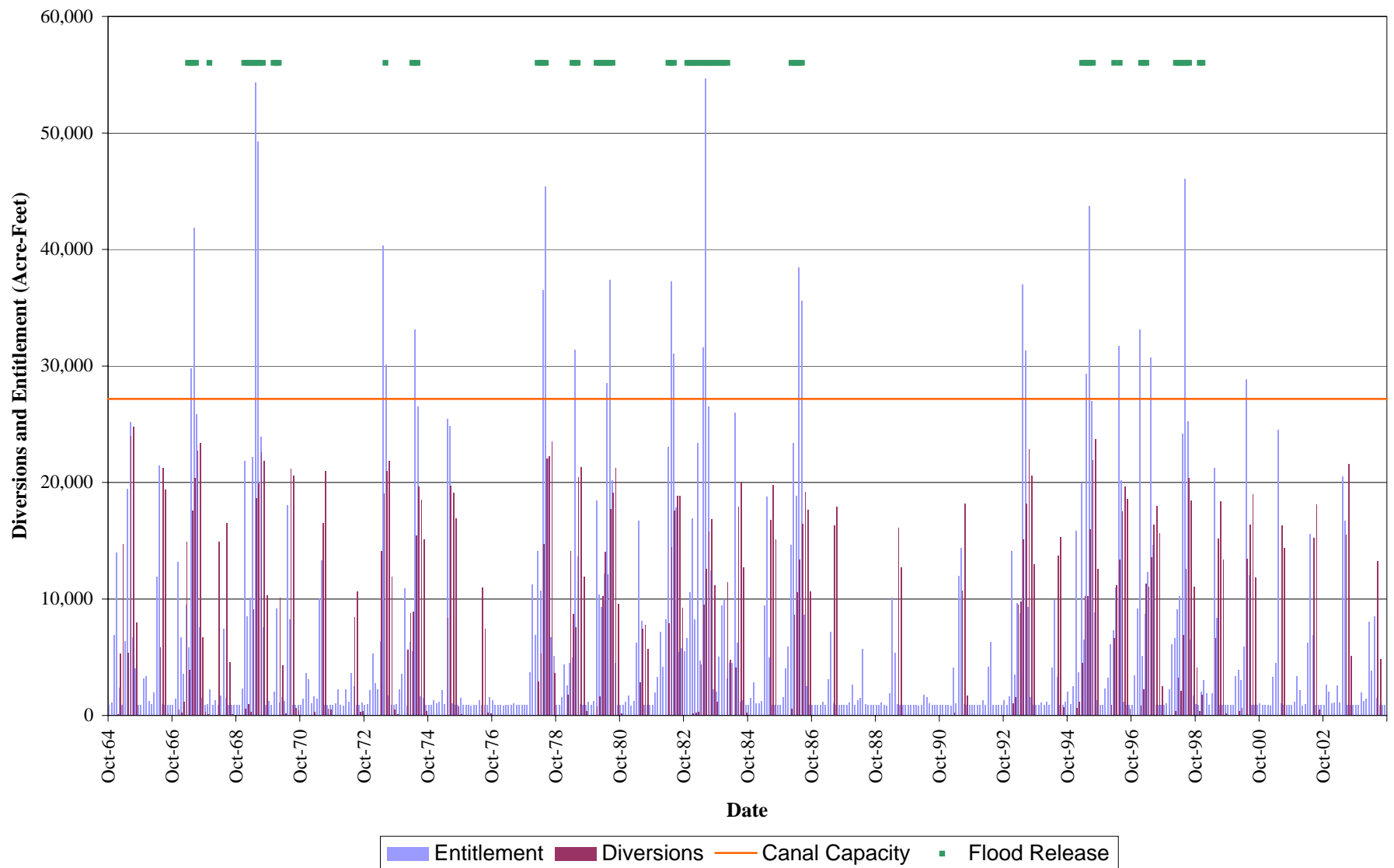


Lower Kings Basin GWMP Update

April 2005

Liberty Canal Diversions and Entitlements

FIGURE E.16

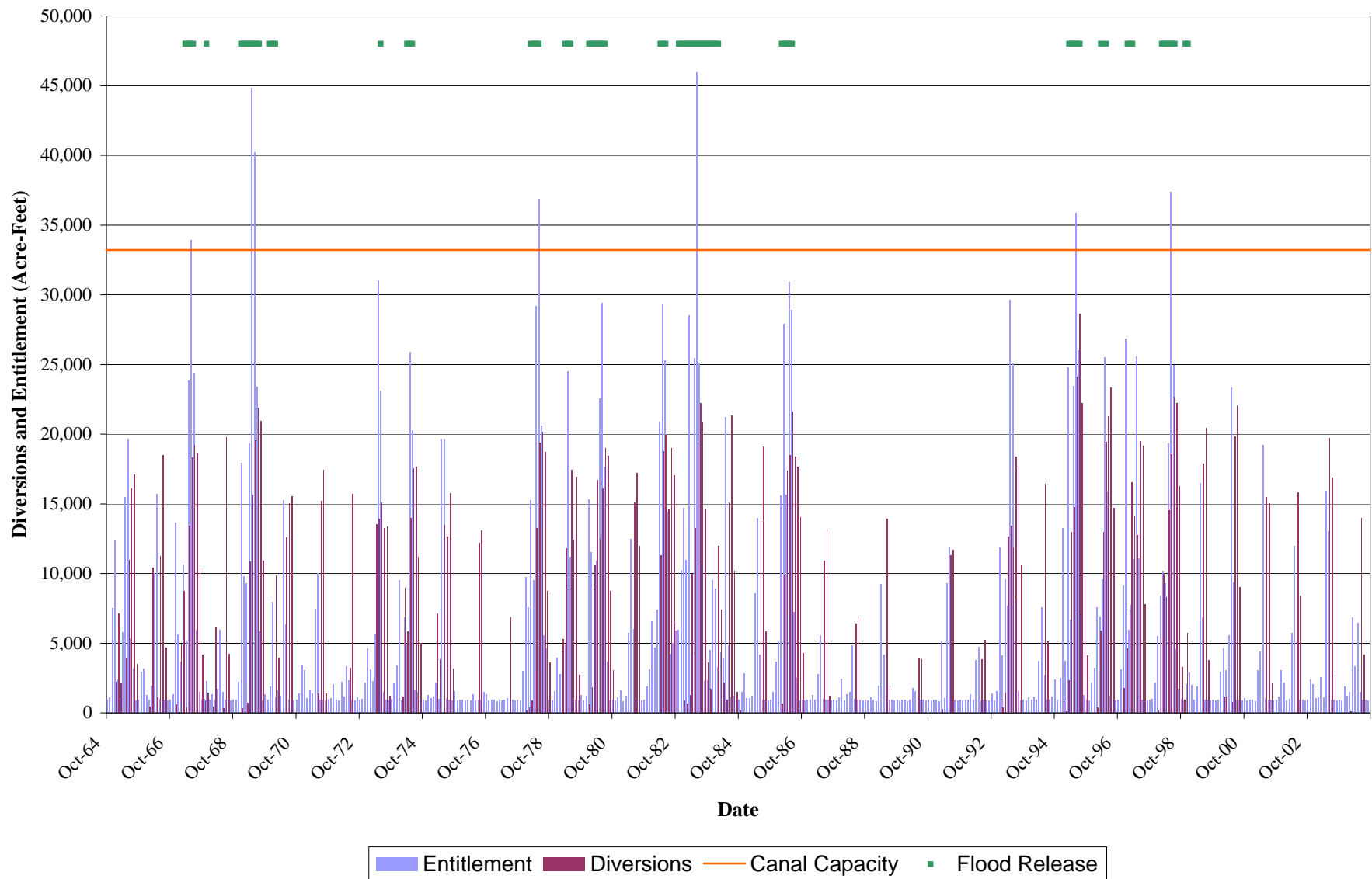


Lower Kings Basin GWMP Update

April 2005

Laguna I.D. Diversions and Entitlements

FIGURE E.17

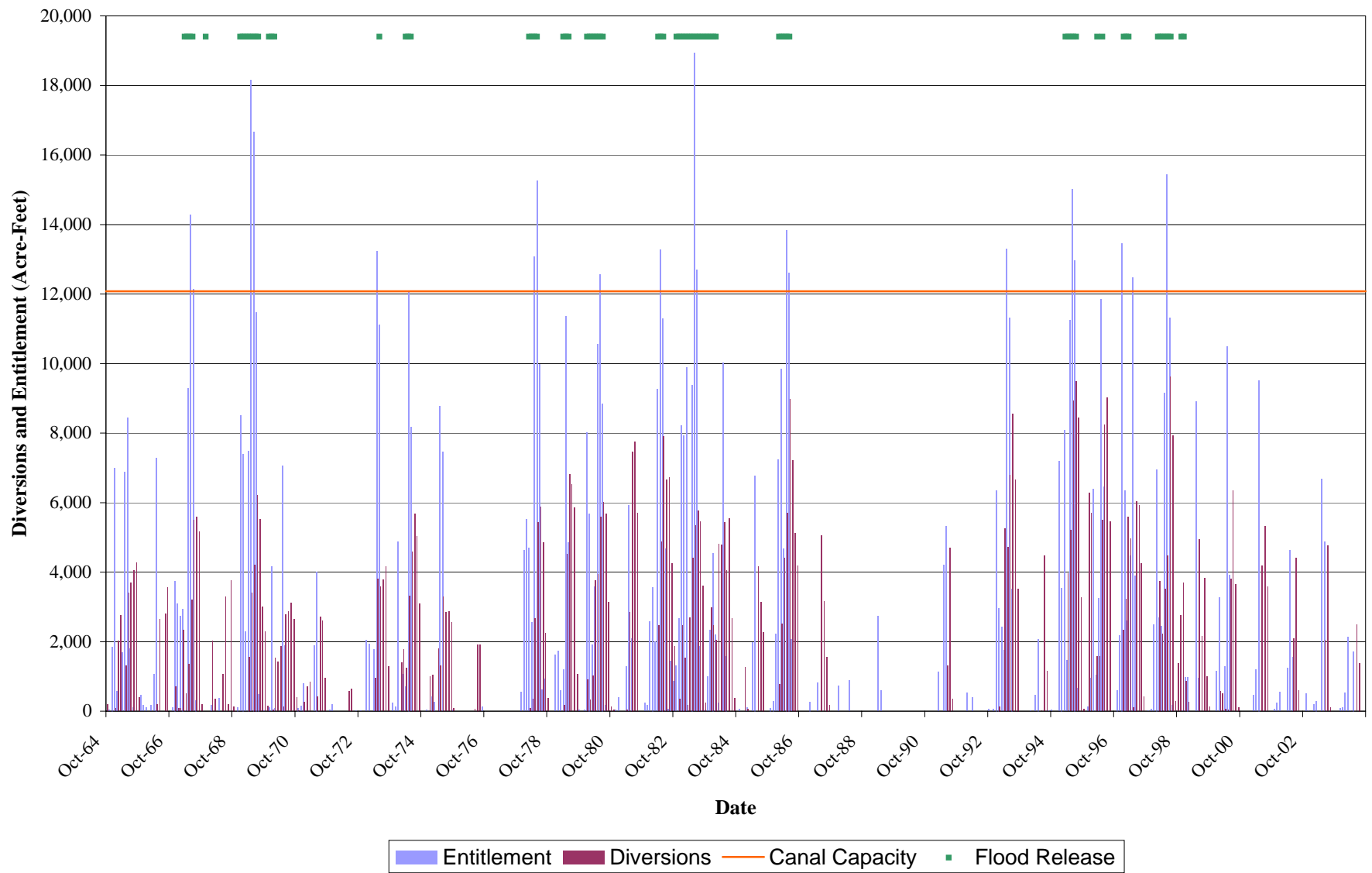


Lower Kings Basin GWMP Update

April 2005

Murphy Slough Diversions and Entitlements

FIGURE E.18

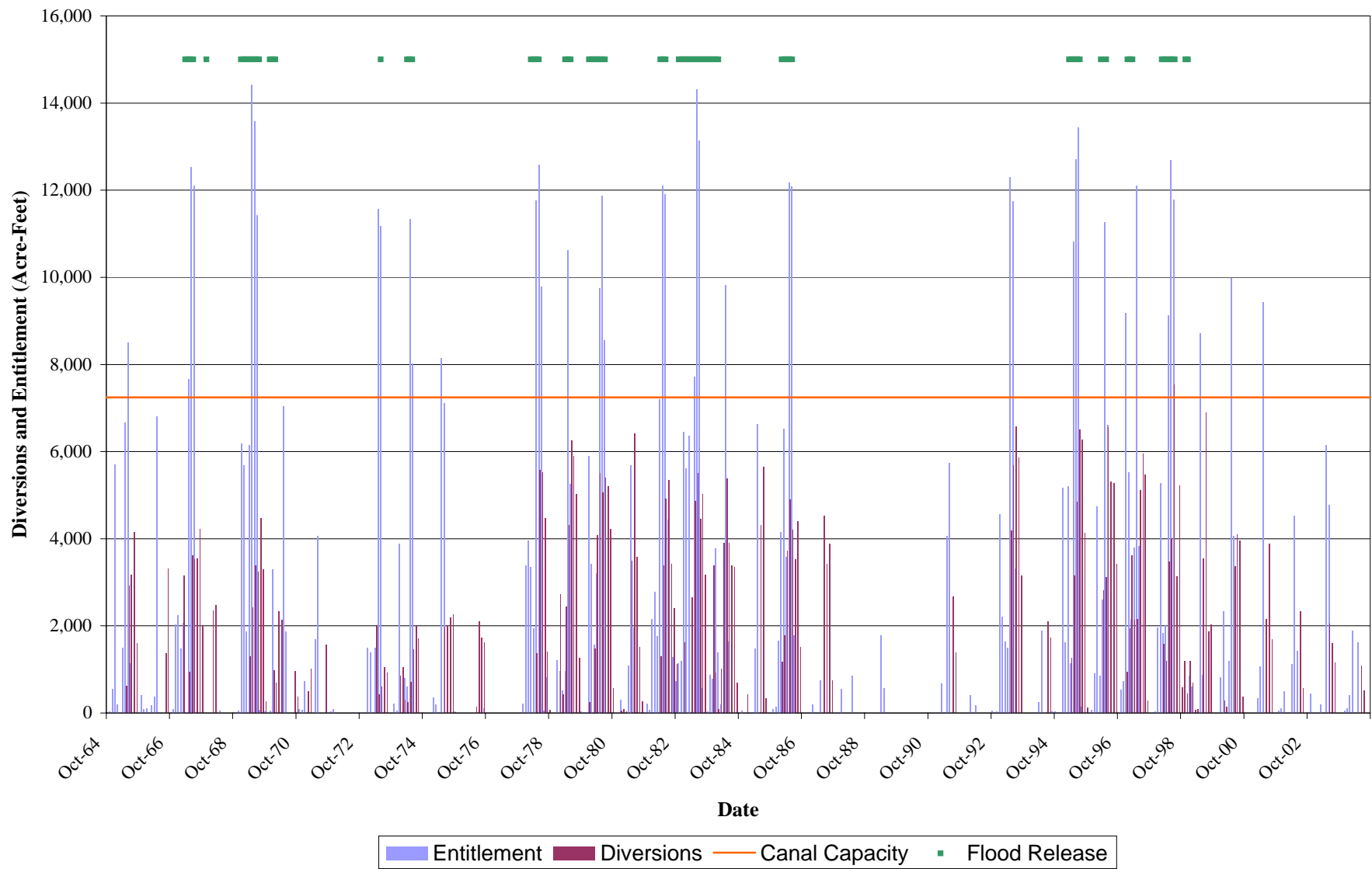


Lower Kings Basin GWMP Update

April 2005

Crescent Canal Diversions and Entitlements

FIGURE E.19

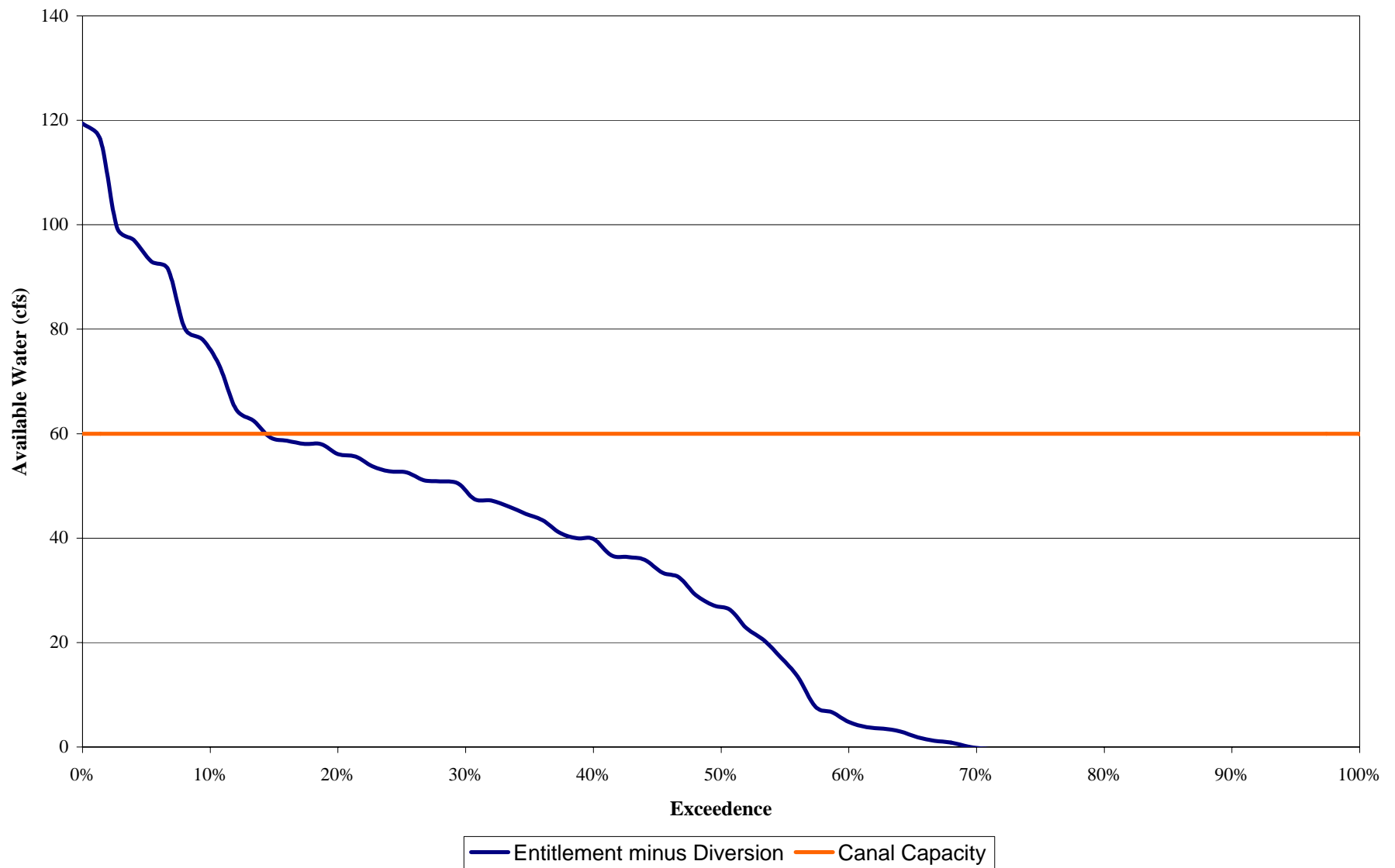


Lower Kings Basin GWMP Update

April 2005

Stinson Canal Diversions and Entitlements

FIGURE E.20

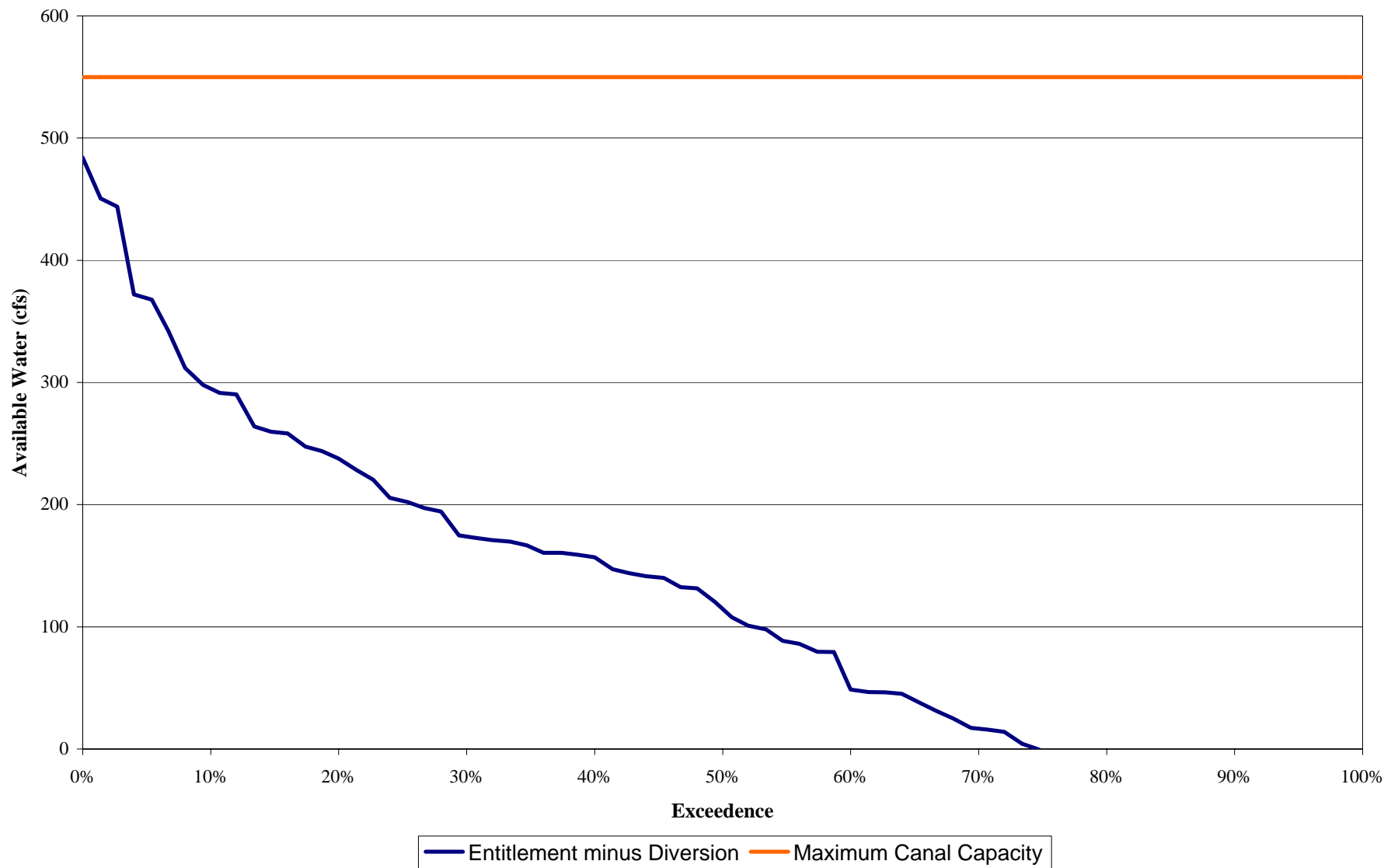


Lower Kings Basin GWMP Update

**Available Water for Diversions Under Entitlement
at Liberty Weir during Flood Release Periods**

April 2005

FIGURE E.21

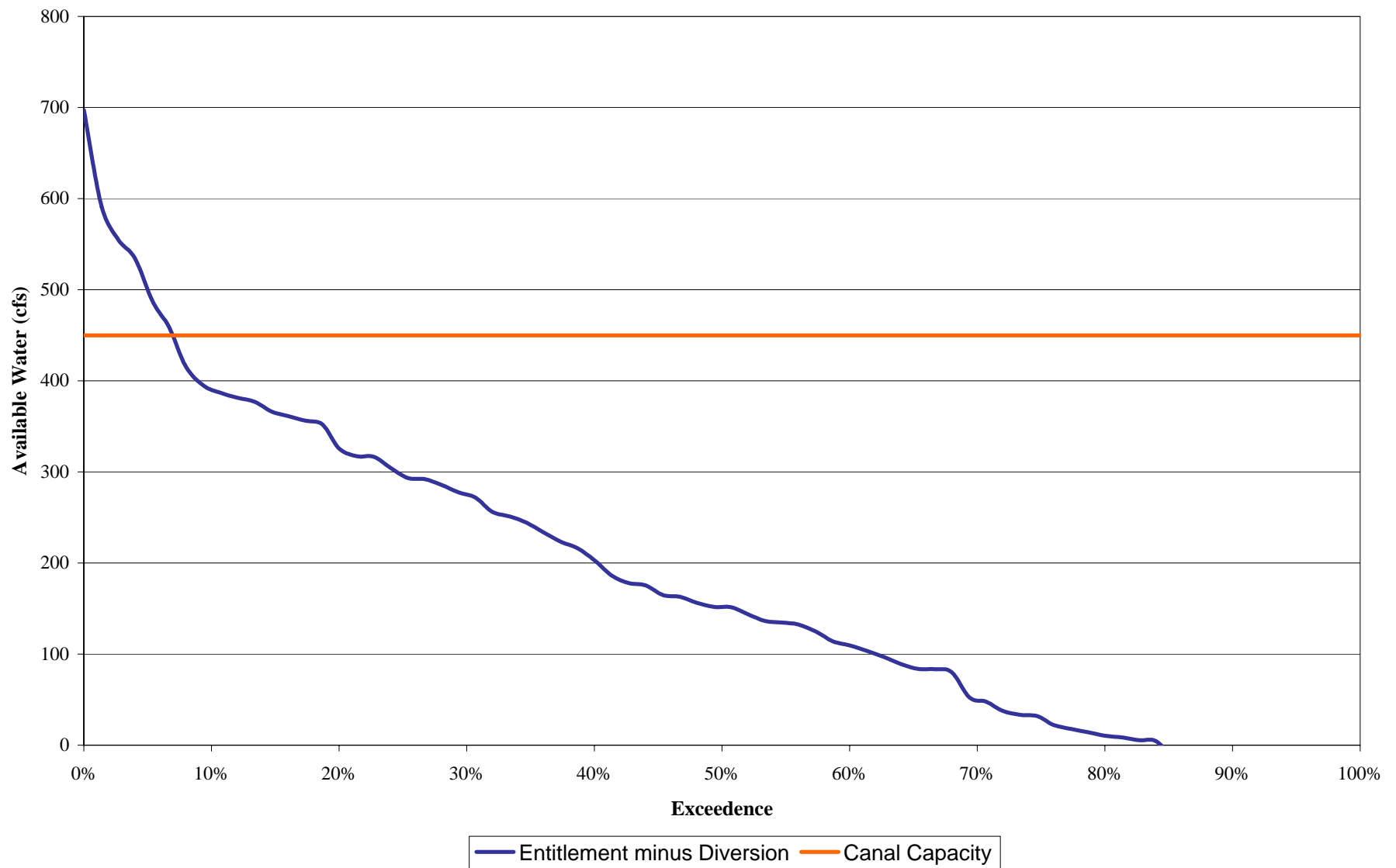


Lower Kings Basin GWMP Update

April 2005

**Available Water for Diversions Under Entitlement
at Murphy Slough Weir during Flood Release Periods**

FIGURE E.22

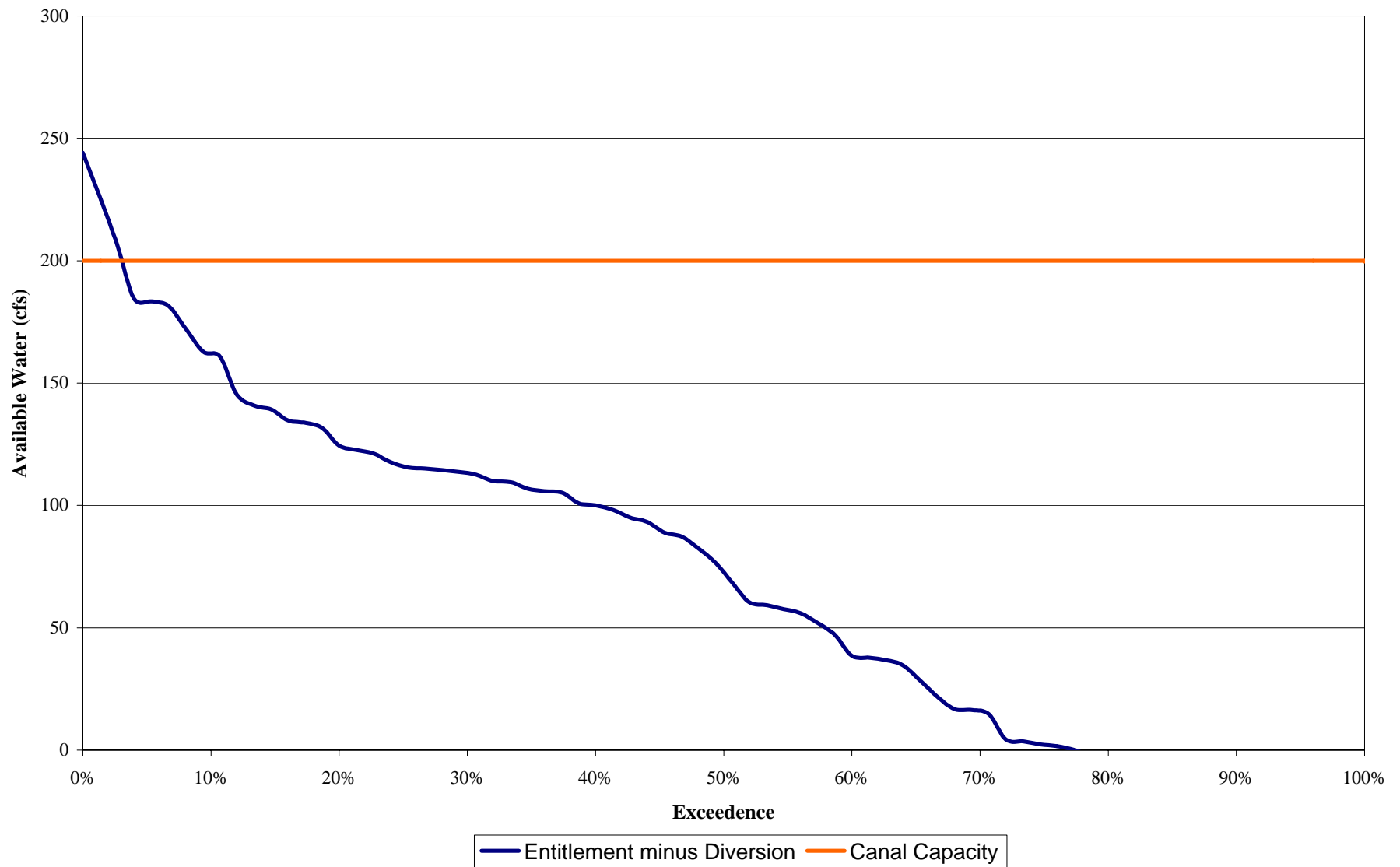


Lower Kings Basin GWMP Update

**Available Water for Diversions Under Entitlement
for Laguna I.D. during Flood Release Periods**

April 2005

FIGURE E.23

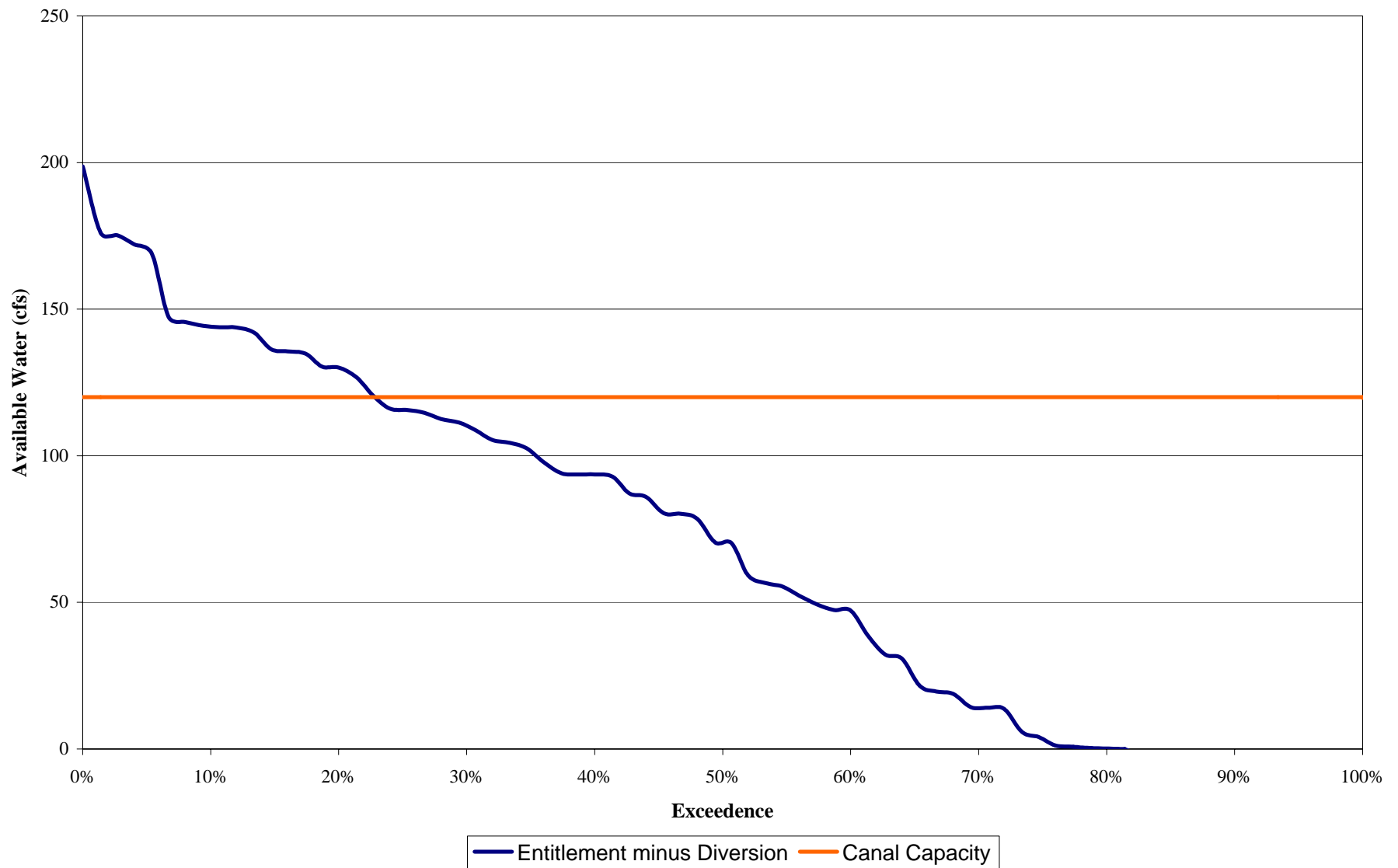


Lower Kings Basin GWMP Update

April 2005

**Available Water for Diversions Under Entitlement
at Crescent Weir during Flood Release Periods**

FIGURE E.24



Lower Kings Basin GWMP Update

April 2005

**Available Water for Diversions Under Entitlement
at Stinson Weir during Flood Release Periods**

FIGURE E.25